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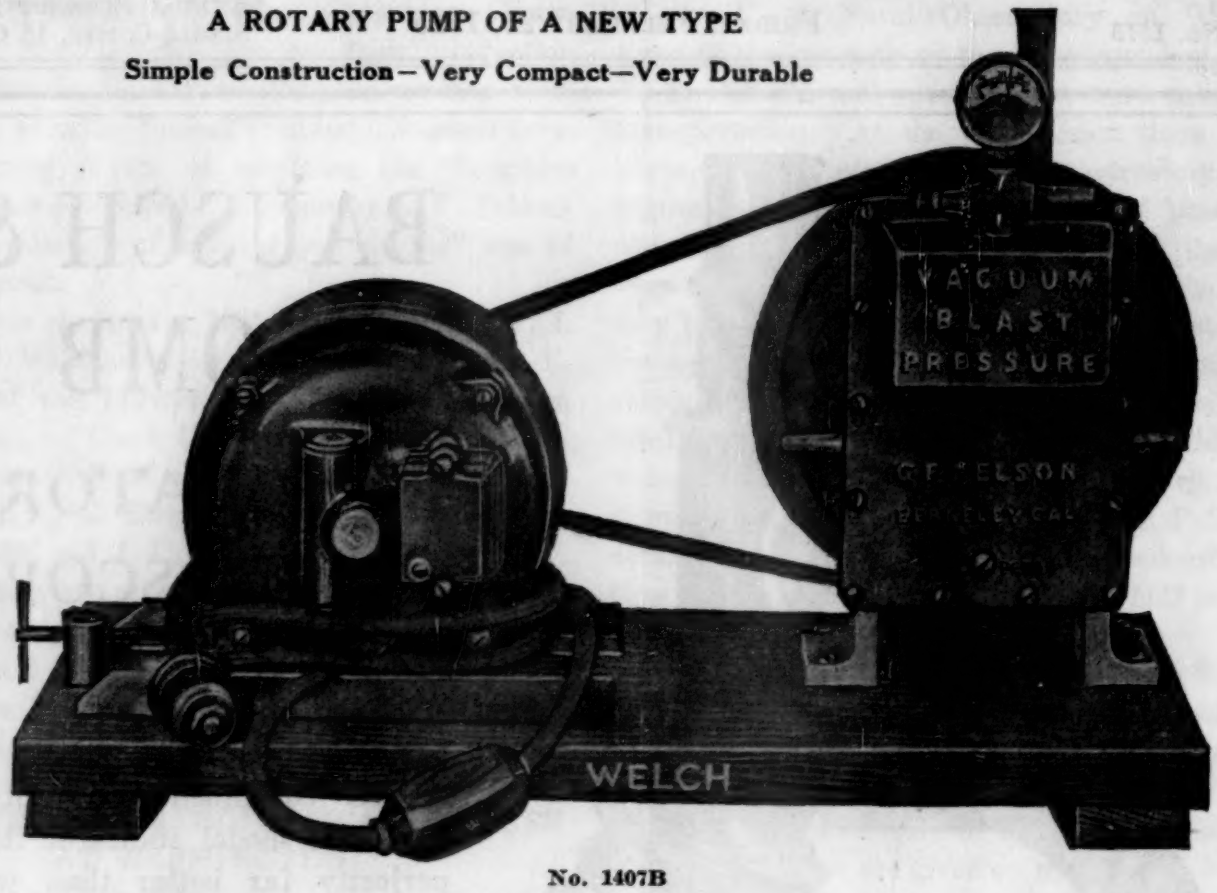

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SCIENCE

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A CLASSIFICATION OF NATURAL RESOURCES[1]

ALONG with the new vogue of Malthusian doctrine there is a marked renewal of interest in the duration of certain natural resources. Research and discussion along this line are bound to be increasingly detailed and searching. One of the prime needs is a workable classification of resources so that issues will not be confused by the grouping together of items which should receive diverse treatment. The primary object of this paper is to distinguish the major divisions in such a classification. There follow some reflections on the outlook for human society in a fully populated world with diminishing resources. The probable effect of these conditions on international relations is then briefly considered.

Natural resources should be considered in at least four primary classes, two of which are exhaustible and two inexhaustible. Let us, for convenience, designate these classes by the four letters, A, B, C and D.

(A) Materials and sources of power which exist in superabundance for all foreseeable time, such as common salt, brick clay, sunlight and nitrogen.

(B) Resources permanent in their nature but limited in amount, like soil and water power.

(C) Resources that are reproduced in crops, renewing themselves regularly and permanently if not exterminated, *e.g.*, fish, forests and various animals.

(D) Limited accumulations not replenished at an appreciable rate. When gone, they are gone forever. Here belong important mineral resources, particularly coal and most of the ores.

As resources are classified here, the problem is different for each class. The duty before us is not the same for any two classes. There was an old style of thrift which taught people merely to save. "A penny saved is a penny earned." But sometimes a penny saved is a penny lost.

Class A, unlimited and inexhaustible resources, tempts the inventor, but is often forgotten by the conservationist. To develop these to the utmost is a duty. Directly or indirectly their use relieves pressure elsewhere.

Nitrogen is the best example of such a resource. Its compounds are all soluble or otherwise unstable, and hence, though incessantly produced in great quan-

[1] Address of the vice-president and chairman of Section E—Geology and Geography—American Association for the Advancement of Science, Washington, December, 1924.

tities by organic means, they have small chance to accumulate. Only in deserts have moderate stores accumulated. At the current rate of consumption the nitrates of the Andes might last for something more than a century, but agriculture should be using vastly more than it does.

The story of nitrate manufacture by drawing on the atmospheric supply need not be recounted, but some may be interested in the arithmetic of the problem. In 1918 when the United States government was manufacturing nitrate at Mussel Shoals, a body of local citizens prepared a protest, setting forth that the atmosphere of the county was being depleted and pointing to sundry phenomena as proof. This led to a simple calculation which showed that one cubic mile of air at sea level contains about twice the nitrogen now being withdrawn annually by fixation plants. The world's entire atmosphere contains six billion times as much. Moreover, all withdrawals are quickly restored by the decomposition of the compounds. So the world's supply of ciphers would scarcely suffice to write the decimal which would express the depletion of the atmosphere by all the fixation plants that the world could use.

But nitrogen alone will make neither fertilizer nor gunpowder. It must be stored in nitrates. If the compound be of potash or soda we are again limited by the base employed, to say nothing of the energy consumed in the manufacture. It is true that nitrate of ammonia contains no ingredient that is exhaustible, but even so we must not forget the power used in its manufacture, and its use is largely confined to explosives. It should be stated clearly that there is probably no inexhaustible substance on earth whose availability in civilized life is not limited by something else.

It is worth noting that the superabundant supply of nitrogen is now tapped in another way, that is, by the way of nitrogen-fixing bacteria. This double success with nitrogen is so spectacular as to be in danger of fostering vain hopes concerning other substances. But it must be remembered that the world's stock of nitrogen is not in compounds. It is at least free to make engagements, though not very anxious or even willing to do so. With most other substances a divorce is necessary before a new attachment can be made.

Building materials afford an impressive contrast between exhaustible and inexhaustible resources. Wood will be mentioned under another class. It is enough to say here that as a primary building material it belongs to the past and not to the future. Stone and common clays are inexhaustible; perhaps also cement materials. We are changing slowly, but why so slow? Those who think in terms of styles and markets, supply and demand, may find the reasons adequate, but to the man who thinks in terms of an ordered world and of the future, the change from wood to mineral substances is absurdly slow. In the nature of the case the latter are inexhaustible. These artificial portions of the earth's crust which we call brick and stone houses are only rearrangements of the crustal materials and it is hard to see how they need become impossible so long as there is a crust left to live on.

It would not be easy to add other illustrations of equal importance in Class A. The list now is much the same as it was 20 years ago, though production has in the meantime been facilitated. Hopes were excited then as now of illimitable potash to be taken from the sea or from felspathic rocks, of aluminum from the silicates, of the power to be derived from tides, from the sun's rays, and from the earth's internal heat. Science is still standing in a reverie before these problems as it stood before most of them twenty years ago and twenty years before that. A similar illustration, not known twenty years ago, but much spoken of these days, is found in the internal energy of the atom. No one knows as yet whether, even theoretically, the amount of energy afforded by a disrupted atom would be greater than the amount needed to disrupt it.

All these examples are matters of common knowledge. They give some idea of the nature of the problems in Class A and of the immense significance of making such resources available. They show also the precarious nature of the world's hope in so far as it rests on discoveries not yet made. The public to-day has a childish faith that science will discover something. When confronted with the elementary facts about the waste of resources, the unthinking man consoles himself with "Oh, science will discover something." The less a man knows of the conservation of energy, the more satisfying this faith is. Some of us call it optimism, some faith, some superstition, and some plain ignorance. There is an optimism that elevates and there is an optimism that degrades and leads to ruin.

Turning from superabundant things, we come to those which, while inexhaustible, are limited in amount, that amount being small enough to insure their complete appropriation. Two outstanding examples are important beyond all others. There are soil and water power. There will always be soil, but the supply will never again equal the demand. It may be wasted, but not wholly destroyed. Whether conserved or wasted, improved or impoverished, it will limit the world's population and the pressure of the bands will cause suffering.

The significance of water power is set forth by

linking it, and it only, with the soil, the two forming almost a class by themselves. Civilization depends almost as much on power as on food. So far as science can forecast, water is to be the great dependable source of power when the fuels are exhausted. These two great resources, soil for food, and water for power, are alike indestructible and limited in amount. The problems which they create differ categorically from those of destructible materials on the one hand and of unlimited supplies on the other. The significant point respecting Class B is its ownership. It is not so much a question of saving as of social organization. These resources of Class B form the only basis for enduring monopoly and a permanent privileged or "noble" class. The superabundant materials of Class A can not, of course, be monopolized, and any monopoly based on exhaustible supplies will come to an end with the exhaustion of its basis. All orders of nobility in the past have been based on the soil, yet in the worst nobility-ridden country on earth the property basis of a privileged class has never been better than that which is afforded by water power in half a dozen leading nations. A family that owns a Niagara need only *sit tight* like an English lord. But even sitting tight will not insure a permanent income from an oil or steel monopoly.

Our Conservation Commission computed nearly twenty years ago that when the water powers of the United States are developed to their fullest capacity, assuming all possible storage and the use of power not available throughout the whole year, the grand total will rise to 200 million horse power with a rental value of 4 billion dollars a year (at twenty dollars per horse power per year) and a capital value of 100 billion dollars. This is vastly greater than the value of all our farm lands. The latter will, of course, increase greatly in value; but the assumed value of the former is based on the continuance of coal. What will be the value of the waters when the coal is gone?

The problems of irrigation have much in common with those of power, but the uses of water for navigation and municipal supplies are government functions and the problems which they present are of a different nature.

The facts here presented are old, yet the nature of the problem is not commonly perceived. Emphasis is here placed on the fact that there are only two resources of the first magnitude which are inexhaustible and yet limited; that one of these has afforded the basis of all orders of nobility in the past and that the rights to the other are now being determined. Twenty years ago it was among the possibilities that this vast estate, many times greater than all that William the Conqueror gave to his retainers, would be used to establish a permanently endowed class in America.

In the treatment of this Class B it is a pleasure to record progress since the Conservation Commission did its work. At that time the federal government had just asserted its right to charge a rental for power developed at dams built by the government itself to improve navigation. No right was yet asserted and vindicated to make a similar charge when a company was granted the privilege of building its own dam for power purposes. It was not until the federal power act was passed in 1920 that the United States made clear announcement of its intention to treat the water power of navigable streams as the property of all the people. It is now clear that the power of streams over which the federal government has control will be leased for terms not exceeding 50 years. As for state policies, some states were in advance of the United States and others are more backward. As late as 1909 New York granted perpetual franchises practically without charge (25 cents per horse power per year).

Class C comprises exhaustible resources which are, however, continuously reproduced at a slow rate unless exterminated. To think of these in terms of Class A, or Class B, and to treat them accordingly would be to miss the point entirely and to confuse the issue. The foremost member of this class is forests, one of the first items which stimulated the conservation movement. In the same class with forests we must consider fisheries of all kinds and all animals which are taken as game or captured, like elephants, to be domesticated. The elephant is a noble race and serves man well, but he breeds poorly in captivity and the rate at which the wild stock is drawn upon may exterminate the race in 100 years (Williston). What would the Indian or the Siamese say to such a forecast? A man not blinded by self-interest or by "business principles" would probably say: "Find out at once as nearly as possible how many wild elephants are born in a year and limit killing and capture accordingly. If life and business in tropical Asia are so organized as to use up more than the annual crop, then reorganize life and business at once, instead of letting them go to smash later." It would be pleasant to hear a business man give that answer instead of saying: "That's all right, but it's not business. I'm not in business for my health. The elephant will last as long as I do."

Returning to the more familiar illustration of forests, it would be a pleasure to record that the agitation in President Roosevelt's time resulted in changing the practice. Our forests then covered 550 million acres; they now cover 470 million acres. They

were then growing annually 7 billion cubic feet of wood and we were taking from them 23 billion. The latest figures show a slightly increased use and a reduction of annual growth from 7 billion to 6 billion cubic feet. These figures afford little hope that wise practice begun in time may avoid actual hardship. Meantime wood is rapidly becoming a semi-precious substance.

There should be no questions about America's future supply of wood. There is more than room for all necessary forests when every acre of good agricultural land is in crops and all the good pasture land is in grass. We can balance our annual wood account in either of two ways. Our annual increment of growth instead of being 6 billion cubic feet may be more than doubled by mere care along old lines of practice, and more than quadrupled by forestry methods which are a century old in Europe. This alone would balance our account. Or, if we prefer, we may reduce consumption. In prewar days the per capita use of wood in Germany was one seventh of ours. In France it was one tenth, and in Great Britain not much more than one twentieth. Substitute materials in all cases come largely from what we have designated Class A, unlimited and inexhaustible resources. Of course, no one asks that our use of wood shall be reduced to a European basis, nor is it necessary. But the sensible thing to do would be to slow down when we see the wall ahead and not come up against it with a crash.

The problems of Class C require no higher mathematics. Arithmetic and common sense are the only prerequisites. It is almost irrelevant to talk about research if we mean to make it a substitute for common sense.

The facts about Class D are always disquieting. It is given to every thoughtful man to be shocked at least once when he first realizes that some very common and supposedly necessary substances have not long to last. It requires a good imagination to visualize life even in the 21st century. Of course, coal will still be with us, unless the present geometrical progression in the rate of usage should continue, which no one expects. On the other hand, no one expects the rate to remain fixed. The world has still to double in population and most of this increase will be in the white race which is the coal-using race. It is small satisfaction to know that we have 2,000 years' coal supply if used at the present rate. Probably no statistician would compute that the rate will not be doubled again, and more than likely at least twice. At any rate we have ahead of us a small fraction of the Christian era before this basic condition of life will be so changed that imagination fails to draw the picture. Long before its exhaustion the price of coal will be what we would now call ruinous. At the same time greatly increased quantities will be needed to extract the diminishing metals from what we would not now call ore, but wall rock or country rock.

Iron is among the most abundant elements of the earth's crust. As a precious or even semi-precious metal it can never be exhausted. But as a base metal the supply depends on a degree of concentration which occurs only in isolated bodies which we call ore. It is not to be supposed that all the great iron ore deposits of the world are known, but even making fair allowance for new discoveries, as well as for increased usage, it would take a brave statistician to promise more than a century of iron at prices which would belong in the present class.

Copper belongs with cheap iron and some other things of which it may be said: There is no certainty of a century, but even if the time be two centuries the moral would be the same. In any case the cost in terms of human labor will be greatly increased. If water power is to have the importance predicted, copper for electrical appliances will apparently be almost a necessary factor in civilization.

It is unnecessary here to enter upon a calculation of the constantly growing stock on hand of all the metals. The proportion actually used up and lost is constantly decreasing. None the less, the growing use far outruns the accumulation and the metals are being mined at ever increasing rates. There is no reason to hope that accumulation will ever be so great as to prevent an unprecedented rise in price at the first indication of final failure of the mines.

The mention of increased cost is about equivalent to saying that an increased proportion of human time and effort must be given to earning the metals to keep a mechanical civilization going. One might receive this statement with equanimity if he had not just been told that an increased proportion of his future time and effort must be given to food-getting. Probably no one questions these obvious assertions except to waive them in favor of those uncertain scientific discoveries with regard to which the public is so confident and scientific men so cautious. The argument that an increased proportion of human effort must be given to producing wool and cotton for clothing is quite as convincing even if less direct.

One begins to wonder what will be left of human life after all these baser but necessary functions have exacted their increases of time and effort. Could there be any mistake in the reasoning? The reasoning is right. Human wants are supplied partly by labor and partly by mere *bonus* of nature. Labor merely supplements the bonus. As the bonus goes up or down, labor goes down or up. In certain con-

ditions of life bananas are almost a pure bonus. Fish may be approximately so when sufficiently abundant. With fertile soil and small population, the bonus element is large. With depleting soil and increasing population the labor element increases constantly.

It is unnecessary to formulate the corresponding statement for coal and metals. The application is obvious. Perhaps the most spectacular bonus ever given to the race was natural gas and liquid oil. The equivalent in labor would have been beyond computation. The complete expenditure of America's share of this bonus is so close at hand as to be sensational. The rest will follow in a few years; then comes the painful effort to get the same value from oil shales, in which case the bonus element is smaller and the labor element is larger.

This line of reasoning would not lead us to a leisured or leisurely world. Natural resources are simply nature's bonuses. Half of them are expendable and very temporary. Most of the rest are limited in amount and constantly being divided up among more and more people. Aside from the depleting of some soils the expending process scarcely began before the middle of the nineteenth century. Some of these bonuses are now nearly spent, and the race is preparing, as it were, to go back to work. Others will be spent within this century. In most if not all cases the necessary labor to supplement nature's gift and make it available will be distinctly greater in 100 years from now.

There is a superficial way of reasoning about the future by analogies with the recent past, oblivious of diminishing returns, heedless of the calculus of curves and even of simple arithmetical sums. Such mental processes may lead to visions of indefinite development of our present mechanical civilization, always with growing wealth and luxury and always with increasing foreign commerce. The picture generally includes an orgy of science and invention which liberates unlimited stores of everything the race may need or wish for.

The future outcome of science and invention is, of course, unknown. As for the known factors in the above forecast, they warrant no such picture. A stronger case may be made out for the attainment of a maximum rate of advance to be followed by a gradual slowing down; a maximum degree of complexity in our civilization to be followed by returning simplicity. So far as can be seen the use of mechanical energy (now mainly from coal) will follow such a course. The use of all metals will follow the same course, the cost of iron in a few centuries becoming similar to that of copper or lead to-day. It would seem that an increasing portion of human life must be given to the mere wresting of food from a limited soil for a greatly increased population. What with the low cost of human beings and the high cost of machinery it would not be surprising to see much machine work revert to simpler methods.

Increased efficiency in labor, in machinery and in organization would retard rather than prevent the changes which are here forecast. Revolutionary discoveries may be made, but for the present these are speculative factors and do not enter into the calculation.

It does not follow that the diminished vitality of material civilization should involve a loss of intellectual life. It might even be that for a time great intellectual energies might be turned into new directions. Still, so mundane is our nature that periods of the world's greatest intellectual activity have generally been associated in some way with material expansion, and the first assumption would be that the present intellectual blaze is in a way dependent on the recent opening up of the rich coffers to which the key has just been found. It is, of course, conceivable that the momentum of intellectual activity may be such as to carry on a material civilization into constantly new fields by constant new discoveries to take the place of exhausted resources. This is what the optimist looks for with a credulity that he would ridicule in religion.

Any forecast based on known factors would probably provide for the burning out of the fires of our complex mechanical civilization, supported as it is by stored up and exhaustible resources, and after that again the simple life, not in detail like that of our fathers, but less complex and distracting than our own. According to his temperament the observer may look for a subsidence of the intellectual level or for a great blooming and fruiting in the realm of mind. In any case we are in the midst of a great experience; spending a bonus which the race overlooked for half a million years and which can not last half a thousand.

The relation of natural resources to national interests and international relations is a phase of the question which greatly interests us at present. All questions about national concerns lead into the one great question of peace and war. The idea is gaining much currency that as the world fills up and its remaining resources are appropriated or used up, the scramble for what is left will become progressively fiercer and wars more common. This seems to us plausible rather than convincing. A proper classification of natural resources ought to aid clear thinking on such a question.

The superabundant resources of Class A ought scarcely to cause trouble among nations. The same

is true of Class C, resources reproducible by crops. It is, of course, conceivable that issues should arise over forests or over the right to fish in certain waters, both of which have caused trouble in the past, but these are scarcely of the order contemplated in the alarming forecast referred to above. Sharp national issues arise over resources of Class B and Class D.

The great resources in Class B are soil and water power. Wars have been fought over the former and may yet be fought over the latter. The soil problem and the food problem are inseparable. Migration of peoples, always accompanied by wars, have been ascribed more largely to the food motive than to any other. There was a time when there was no other way of shifting from an overpopulated area to one where the soil could support more people. More recently emigration from country to country has been a personal and peaceful matter. With such a method general, a fluid population would move peacefully like currents of air from places of greater pressure to places of less until the pressure is equalized. Against this peaceful flow, barriers are beginning to be erected and it is not improbable that these will be multiplied as the world fills up. It is conceivable that we may come again to the condition in which migrations must be military if made at all. In other words, immigration questions are related to the larger question of the soil and may conceivably cause national conflicts.

It is not easy to point to an international crisis in modern history in which the acquisition of soil for food purposes was a major consideration. An admixture of economic motives in most if not all wars is now recognized by every one. Disputes about trading rights have been among the commonest causes of war. But fighting for trade must not be confused with fighting for life or for the necessary food to support life. The two are about as much alike as the scramble to get rich is like hunting for a job. All the wars for trade in all history afford no precedent for what is being depicted as a final life and death struggle for soil to grow food on.

Admittedly such a struggle would have to be for an area not fully peopled, as no one has yet assumed the extermination of a people for the purpose of appropriating its food supply. This almost limits the problem to the current century, as no one seems to expect that any country after that will be less than fully farmed. There will, however, still be differences in the pressure against their several capacities, the logical results of these differences being emigration and trade. Issues, therefore, will be much less apt to concern the political title to this or that area than the right to emigrate and the right to buy. Both of these questions need study from the world standpoint. But the broad assumption of a wholesale war scramble for food lands seems to be snap judgment. It may even be worth pointing out that the overpopulated and underfed countries of the world are not now aggressive. India and China are not feared. The one country which was the bugbear of Europe for several generations is the one which has the greatest area of fertile soil. A hungry man may fight for food so long as he remembers what a good meal tastes like. But national hunger comes on slowly and it remains to be demonstrated that a nation long underfed is dangerous.

The resources of Class D are undeniably bones of contention. They are for the most part minerals; largely basic materials used in manufactures. Any one of them may hold the key to a national industry. A substance not found in the home country may be needed with terrible urgency. Yet some one may be guarding the supply. It is scarcely in human nature not to measure your wits and your strength against those of the guard.

The precious metals were the prize played for in the Spanish conquest of the new world. The gold of the Rand was the real cause of the Boer War. Without the iron ores of Lorraine there would have been no Franco-Prussian War in 1870 and probably no World War in 1914. Chile fought both Bolivia and Peru for nitrate deposits. Recently our own country came perilously near going to war with Mexico in order to "develop her resources." The petroleum situation in the world to-day is aflame with possibilities and is of the same nature as others which have brought on wars.

Most but not all attempts at forcible seizure of raw materials have been directed against the so-called backward nations. With small countries of little diplomatic standing the issue has taken the form of collecting or protecting debts, or maintaining order. In large countries poor in capital, "concessions" now break the ground in which the seeds of war and conquest may be sowed. In practically all such cases the *foreign investment* has been the first of a series of steps leading up to the use of an army on foreign soil.

There is no way of obviating foreign investments. The distribution of the world's reserves of exhaustible resources is startlingly different from the distribution of the world's capital. The latter must move to the former. It is, therefore, among the necessities of the case that much of the world's raw material shall be brought into world's life by foreign capital. Provision for this involves some relation between the two countries. From the standpoint of peace and war this relation is the most delicate and dangerous thing that confronts the world in the next 100 years.

The capital in a country becomes saturated just as population does. Some nations are overcapitalized as others are overpopulated. When all temporary expedients are exhausted both people and capital must emigrate or die. In a world no longer colonizable it is no longer practicable for large bodies of men to move to another domain and retain their old allegiance and citizenship. This may be a real hardship. It is not pleasant for a million home-loving Germans to leave the Fatherland and not form a new and tributary Germany elsewhere, but men whom fate compels to move must play the game with fate according to the rules.

The tendency of capital to retain its old allegiance after emigration is quite as strong as the same tendency in men. The extent to which capital invested in a foreign country retains its citizenship in the home country is ill defined. It varies between two extremes. If the two countries are equally strong, or if the place of investment is in the stronger country (a very rare case) the right of that country to make its own commercial laws may be fully recognized, just as immigrants to the United States from Czecho-Slovakia expect to be tried by the laws of this country without appeal to their own. But in the more usual case, where the investment is made by citizens of a powerful country in the property of a weak country, the actual situation may reach the opposite extreme wherein the acts or wishes of the investor become, almost *ipso facto,* the acts and wishes of his government. Between these two extremes there is great uncertainty and no other question or class of questions for the next century contains so much powder or so many matches.

To a man with a wide knowledge of resources, investments and international dealings, it would be interesting to peer into the future to see what possibilities are enfolded in this question. We may hazard the assumption that resources found in advanced countries (or their colonies) where there is not only understanding of their significance but some ability to share in their development are not apt to be contested in such a way as to endanger the sovereignty of the country.

The statement may also be risked that by the end of this century the resources of backward countries will be about as well known as those of Europe are to-day, and all will be covered by claims of at least one industrial nation with surplus capital seeking investment. Some of the finds will be already exhausted. The significance of this is that the time is limited within which such issues can cause trouble. Those who wish to do so may see in these conditions the occasions of many international clashes. It is not to be assumed that clashes will be wanting, but they should be mainly in the interests of foreign investments made for the purpose of increasing wealth rather than food wars as depicted by those who look forward to a final scramble for the bare means of living. This statement must not be made too categorically, as it must be conceded that national interests, such as the food of the people and the expansion of trade, may be so closely connected as to make it impossible to ascribe a war wholly to the one or to the other.

It is not easy to set the stage for the proposed food wars, even in imagination, unless the imagination is untrammeled by facts. Undernourished nations do not wage war. Moreover, food as an element of foreign commerce is bound to diminish as the great food selling countries become fully populated. As countries fill up they also become industrialized, thus reducing the need for the manufactured imports formerly received in exchange for exported food. The gradual exhaustion of resources in Class D and their rising cost will operate still further to reduce the commerce by which they are at present assembled from the ends of the earth to be fabricated in a few countries and sent again to far-off regions in exchange for food.

The obviously economic plan for a world full of people is for the people to live as near as possible to where the food is produced, and to organize a balanced community in each era, with industrial employment for hands not needed in producing food. It is generally agreed that this tendency exists and that when it becomes dominant foreign commerce will be relatively light. A little reflection will show that wars should diminish with commerce.

There may, however, be an intermediate stage induced by the great temporary demand on foreign investments. It seems highly improbable, at least, that the industrializing of the present food-exporting countries will wait on the slow accumulation of home capital. It is more probable that a loud call for capital from the new country will be supplemented by a shove from the old country. For it must be remembered that when the countries that now feed England (for example) are eating the food at home, England becomes automatically overpopulated, perhaps to the point of disaster. The incentive for capital to move is thus intensified.

It seems wise, therefore, to make allowance in one's forecasts, for a great temporary increase in foreign investments with all their attendant risks. These, rather than food, or soil on which to raise food, would seem to furnish the immediate dangers to world peace within the coming century.

NEVIN M. FENNEMAN
UNIVERSITY OF CINCINNATI

MEMORIAL OF JACQUES LOEB[1]

IT is nearly a year since the passing of Jacques Loeb. We miss his personality, we miss the worker, but the spirit of his work still lives and dominates, for it has been impressed indelibly on the biological advances of the past thirty years.

By nature he was sensitive and timid even to the point of shyness; he avoided publicity and only infrequently appeared on our programs, so that many of us doubtless did not know him. His work, however, has touched, in a basic way, so many fields of scientific research that there are few of us indeed who are not deeply in its debt for suggestion and inspiration.

By methods as simple as they are direct and conclusive, his genius added fundamentally to so many phases of physiology and biology that it can unhesitatingly be said: "He founded 'general physiology' in America."

This is not the time nor is it the occasion to detail at length the achievements of his fearless originality or to dwell upon the biographical incidents which led to their consummation. Suffice it that he was classically schooled in youth and developed a prime interest in general philosophy and psychology. He early became impatient with the results and methods in these fields; he craved something more tangible. This he sought in the physiological laboratory of Goltz at Strasbourg. Later he also came in contact with the botanist Sachs while assistant of Fick in Würzburg.

It is in these contacts that we see foreshadowed that broad outlook on biology which led to his expositions on mammalian brain physiology, to his studies in "Comparative Physiology of the Brain and Comparative Psychology," to his contributions to the physiology of sense organs, "Forced Movements, Tropisms and Animal Conduct." We see in the philosophy which gave us his "Mechanistic Conception of Life" that he found what he sought when he entered the experimental field. His early application of physical chemistry to the analysis of life phenomena led to "Artificial Parthenogenesis" and "Salt Balance," and we see the reflection of these studies in his latest work on the chemistry of colloids and the physico-chemical properties of membranes.

The scope and fundamental nature of his work is well attested by a memorial program at one of our leading universities where papers were read on the relation of Loeb's work to botany, to zoology, to physiology, to pharmacology, to chemistry and to psychology.

But a knowledge of his written word gives no index of the inspiration of personal contact of the student with Loeb, the educator; it is the constant theme of those who worked with him. What science gained when he left the academic field for that of pure research was more than offset by the limitation of his contacts with the youth who might have carried on the torch.

While all who knew him will miss the guidance of his keen mentality and straight thinking, there is a small number who have suffered a loss too great to measure—his close personal friends—who were permitted to know not only the scientist, but also the man, who saw and admired his idealism, who were cheered by his never-failing and subtle humor, who were drawn irresistibly to his simple, loving nature.

Jacques Loeb is gone; it is fitting that we honor the memory of him whose life touched so intimately our lives, whose work has so thoroughly leavened our work.

W. E. GARREY
TULANE UNIVERSITY

[1] Read before the twelfth annual meeting of the American Societies for Experimental Biology, in affiliation with the American Association for Advancement of Science, Washington, December 29 to 31, 1924.

MEMORIAL OF THEODORE HOUGH[1]

THEODORE HOUGH was graduated from the Johns Hopkins University as a doctor of philosophy, with physiology as his principal subject, in 1893. He was the last of the group of men who received their sole training in physiology under Newell Martin. It was a school of physiology which in the period from 1876 to 1893 played an important part in the development of physiological research in this country. In point of numbers it was then contributing a larger percentage of workers in the subject than any other laboratory, and the researches published were thoroughly modern in spirit. This group of men all had a uniform training, based chiefly on a sound knowledge of the biological sciences. In this respect it resembled the Cambridge school, of which indeed it was an offshoot. Enrolled as graduate students in the philosophical faculty of the university, they acquired something of the academic spirit and scholarly attitude that characterizes devotees of the higher learning. Physiology for them was not a handmaid to therapeutical medicine, but an independent far-reaching science that touched the deepest problems of physical and spiritual existence, a science whose "waves wash the shores of the two worlds of matter and of mind." It was a congenial company of young scholars moved by an unselfish desire to promote their subject. Any new fact discovered was welcomed with

[1] Read before the twelfth annual meeting of the American Societies for Experimental Biology, in affiliation with the American Association for Advancement of Science, Washington, December 29 to 31, 1924.

enthusiasm and appreciation as an addition to knowledge, whether or not it seemed to have an immediate bearing on human welfare or the advancement of medical practice. Since that time medicine has become much more scientific, and workers in physiology trained in the professional schools of medicine turn to the fundamental as well as to the practical problems, although physics and chemistry rather than biology constitute the basis of preparation.

Hough's graduation dissertation was upon "The escape of the heart from vagus stimulation." While still a student he investigated the vexatious question of the physiology of the external intercostal muscles and solved the point neatly and completely by the use of the idea, introduced by Martin, that the inspiratory muscles must contract synchronously with the diaphragm and the expiratory muscles alternately with it. After graduation he was appointed instructor in biology with Sedgwick at the Massachusetts Institute of Technology. He was of material assistance to Sedgwick in developing the excellent course in biology for which the institute has been noted, and later the two of them collaborated in the publication of a book on physiology, hygiene and sanitation which in its particular field was a noteworthy and valuable contribution.

During his period of residence in Boston, Hough was in charge also of the biological work in the newly founded Simmons College. In 1907 he was called to the University of Virginia as professor of physiology and later served also as dean of the medical school. He filled both positions at the time of his sudden death on November 30, 1924.

He was one of the early members of the American Physiological Society and for many years was a faithful attendant and a frequent contributor at its meetings. His scientific work was not large in volume, but it was admirable in quality. In his Boston days his researches were devoted mainly to points bearing upon muscular work and fatigue, owing doubtless to the fact that he was engaged as a lecturer in a school of physical training. His somewhat infrequent papers from the University of Virginia dealt chiefly with problems of respiration. Hough was a well-trained physiologist fully acquainted with the literature and technique of his subject. He was very thorough and accurate in his work and was animated by the highest ideals. I can well believe that the medical students of the University of Virginia received from his hands an instruction in physiology as sound and as modern as could have been obtained at any university in the world. His qualities of mind and character easily explain why his colleagues pressed him into service as dean of the medical school. In this position he was as successful as in his teaching work. He took an active part in the national conferences on medical education and devoted a large part of his time and energy to the maintenance and development of his own school through some periods of storm and stress. While the University of Virginia must have profited greatly through his efforts it is, of course, a matter of some regret to his brother physiologists that administrative duties deprived him in large measure of the opportunity for investigation for which he was so well qualified by his training and by his ability. Those of our society who were his friends and comrades will ever remember him for his integrity and sincerity of character, his high ideals of scientific work and his cordial, manly personality.

W. H. HOWELL

JOHNS HOPKINS UNIVERSITY

SCIENTIFIC EVENTS

SCIENTIFIC EXPEDITIONS PLANNED BY FIELD MUSEUM OF NATURAL HISTORY FOR THE YEAR 1925

THE Field Museum of Natural History, of Chicago, has completed arrangements to send into the field during the year 1925 fourteen important expeditions. While several of these expeditions are in continuation of investigations that have been conducted by the institution during the past three years, most of the new undertakings are for original scientific research in fields not heretofore explored by the museum. With one exception, the funds provided for these explorations have been contributed by Captain Marshall Field, through whose generosity the museum in 1922 was encouraged to make arrangements for extensive researches in various parts of the world, covering a period of five or more years. The beginning of the year 1925 finds the following expeditions either in the field or making arrangements for departure.

The museum has commissioned Dr. A. L. Kroeber to collect archeological material in Peru and Bolivia. Dr. Kroeber's initial researches will most likely be at Tiahuauac, on Lake Titicaca, high in the mountains between Peru and Bolivia. Although the Spaniards found the Incas ruling this territory, it has since been agreed that their dynasty was a comparatively young one, probably originating in the fourteenth century. Incomplete investigations made by various institutions have disclosed much that is mythical regarding the pre-Incas races. Sufficient material evidence has been discovered, however, to prove that civilizations existed as long ago as 1,400 years before the Incas.

The archeological expedition in Mesopotamia, conducted jointly by Field Museum and Oxford University, under the leadership of Professor Stephen Langdon, during the past two years, will continue its

operations through the present year. Important discoveries are expected to come from where excavations have gained great headway. The oldest pictorial writings have been unearthed from a palace believed to have been that of the first kings of Babylon. The excavators are now working into some of the more important burial places, temples and fortresses that are expected to yield material of vast importance in reconstructing the story of pre-Semitic and prehistoric Sumerian races.

Madagascar has been selected as the field for an ethnological survey, under the leadership of Dr. Ralph Linton. This is a most promising region for ethnological research. The inhabitants are of cosmopolitan lineage and many of the tribes are closely allied with the Malayan groups farther to the east. The island contains twenty-six different groups of people, which are sub-divided into a greater number of tribes. The southern tribes are almost unknown. They are believed to be descendants of people who ruled the island before the Hovas, the present so-called ruling class. The Hovas apparently came originally from Sumatra. Some of the other tribes are of the Mongolian type. Still others claim to be descendants of the Arabs. The expedition will attempt to make contributions to the early history of the migrations of the Malayan group.

An expedition to southern California, under the leadership of Charles L. Owen, will be financed by the Julius and Augusta N. Rosenwald Fund. Complete data concerning the Hupa, Yorok, Cahuilla and Chemehuevi Indian tribes of that region will be sought.

In continuation of the botanical research in Peru, the museum has commissioned the well-known phytogeographer, Dr. A. Weberbauer, to collect plants in that country. Many new species have already been described among the plants from Peru secured by J. Francis Macbride, of the Department of Botany of the Field Museum, during the years 1922 and 1923. It is believed that further collecting in this region will prove equally profitable.

Primarily for the purpose of adding to the museum exhibition and economic series in the department of botany, Dr. B. E. Dahlgren will conduct an expedition in Cuba.

Further botanical collections will be made in British Guiana by A. C. Persaud, who is in charge of the museum field work of collecting tropical woods.

Dr. Francis W. Pennell has been commissioned to collect botanical material in the central and southern Peru sections of the Andes and along the coast and in the Andes of Chile. The latter country is rich in Scrophulariaceae, to which Dr. Pennell devotes special attention.

The museum will receive material from the Third Asiatic Expedition of the American Museum of Natural History, under the leadership of Dr. Roy Chapman Andrews, through its cooperative agreement with the American Museum.

The paleontological expedition in Patagonia, which has been in the field since 1922, under the leadership of Elmer S. Riggs, will continue its operations during the present year.

The African expedition, which spent the year 1924 in Belgian Congo, will continue in that country. This expedition is in charge of Mr. Edmund Heller, who is accompanied by Mrs. Heller. Recently the expedition has been working in the vicinity of Mt. Ruwenzori and it is expected to spend some time in neighboring localities for special studies of the gorilla and chimpanzee while making general collections of mammals.

An expedition to central Canada, among the lakes and marshes of Saskatchewan, will be carried out by Ashley Hine early in the summer. The object of this expedition will be to secure material for habitat groups of American water birds.

An expedition to Newfoundland will be conducted by Julius Friesser and H. C. Holling to secure group material for large mammal exhibits, especially caribou.

The series of zoological expeditions which the museum has been making to South America will be continued by an extensive survey in central and southern Brazil. This expedition will be undertaken by John T. Zimmer and Colin C. Sanborn. If conditions permit, the party will penetrate into hitherto unexplored regions of the central forests of Brazil, where no zoological collecting has been done. This expedition will make a very thorough collection of mammals, birds and reptiles and will remain in the field into and perhaps throughout the year 1926. In addition to largely increasing the knowledge of the classification and distribution of vertebrates, it is planned to obtain selected examples of the fauna for exhibition purposes, including certain rare monkeys and carnivores and birds of exceptional interest through their rarity or unusual character.

The working collections of the museum will also be augmented during the year by expeditions conducted and privately financed by H. B. Conover, who is at present in the field in the state of Tampico, Mexico.

D. C. DAVIES

FIELD MUSEUM OF NATURAL HISTORY

MEETING OF THE INTERNATIONAL UNION OF SCIENTIFIC RADIO

RADIO research activities of wide scope were discussed at a recent meeting of the American Section of the International Union of Scientific Radio Telegraphy. The meeting was held at the National Re-

search Council, Washington, D. C., and was attended by radio engineers, professors, government scientists and others interested in research from all over the country. The American Section is one of the most active branches of this world-wide organization to promote research on the problems offered by radio waves. The officers of the Section are: *Chairman,* Dr. L. W. Austin; *technical secretary,* Dr. J. H. Dellinger; *corresponding secretary,* Dr. W. E. Tisdale. The president of the International Union is General G. Ferrié, head of the French Military Communication Service. The International Union is to have its triennial meeting in Brussels, Belgium, on July 7 of this year.

At the beginning of the meeting Professor A. E. Kennelly, chairman of the liaison and membership committee, explained the organization and stated that all persons interested in research on radio wave phenomena and related problems may become members. Every member is assigned to work on one of the technical committees. Professor Kennelly also presented a report briefly outlining plans for radio measurements by a number of laboratories during the solar eclipse of January 24.

Reports were presented by the chairmen of the section's five technical committees. Dr. J. H. Dellinger, chairman of the committee on "Methods of measurement and standards," spoke of the great increase of interest in radio measurements arising because so many people have gone into all phases of radio design and engineering and have found it essential to secure real measurements. There is outstanding progress in the accurate measurement of radio frequencies, which has attained international importance and popular as well as scientific interest because the reduction of interference in radio reception depends upon it. The work of numerous investigators and laboratories is providing means to give the necessary precision of measurement, constancy of adjustment and absolute accuracy of frequency basis. International comparisons of frequency standards have shown a very satisfactory agreement.

Dr. L. W. Austin, chairman of the committee on "Radio wave transmission phenomena" presented the report of that committee. The variations of the intensity of received signals from the high power station at Bordeaux, France, have been found to be the same in France and in the United States whereas no such correspondence in the received signals is found for measurements in the two countries on the transmitted waves from the high power station at Rocky Point, Long Island. In measurements on the strength of signals from European stations there is found a drop in signal strength just after the time of sunset in Europe.

Dr. A. H. Taylor reported work of the committee on "Variations of radio wave direction." It has been found that a shift of the apparent direction of the waves from long wave stations occurs at sunset. The direction shifts toward the east before sunset, returns to normal at sunset, and then usually shifts to the west.

Mr. E. F. W. Alexanderson presented the report of the committee on "Measurement of interfering radiation." A portable direct-reading instrument for field strength measurements has been developed. This instrument will make it possible to determine the precise amount of interference not only on the main wave of a station but in the side bands and harmonics. The use of a standardized direct-reading instrument of this kind will make it possible to obtain actual statistical data on interference produced by various radio stations and other sources.

MEETING OF THE ASSOCIATION OF AMERICAN MEDICAL COLLEGES

THE thirty-fifth annual meeting of the Association of American Medical Colleges will be held in Boston from March 5 to 7, the headquarters being at the Copley-Plaza Hotel. The program will be as follows:

THURSDAY, BOSTON CITY HOSPITAL, 9:30 A. M.

Medical sociology and environmental medicine, Charles P. Emerson, dean, University of Indiana School of Medicine.

Bearing of neuropsychiatry on public health problem, Albert M. Barrett, professor of neuropsychiatry, University of Michigan Medical School.

Education in preventive medicine in regular curriculum, Haven Emerson, professor of public health administration, Columbia University.

Teaching of preventive medicine, Samuel R. Haythorne, professor of pathology and bacteriology and director of hygiene, University of Pittsburgh School of Medicine.

2 P. M.

Address of president: The future practitioner, Ray Lyman Wilbur, president, Stanford University.

Correlation in the curriculum, Bernard F. McGrath, director of the surgical laboratories, and professor of principles of surgery, Marquette University School of Medicine, Milwaukee.

Teaching of obstetrics, J. M. H. Rowland, dean and professor of obstetrics, University of Maryland School of Medicine.

Teaching of physiotherapeutic measures, W. H. MacCraken, dean, professor and director, Detroit College of Medicine and Surgery.

FRIDAY, 8:30 A. M.

Practical demonstration in medical teaching at Harvard Medical School, Boston University School of Medicine and Tufts College Medical School.

HARVARD MEDICAL SCHOOL, 2 P. M.

Remarks by A. Lawrence Lowell, Ph.D., president, Harvard University.

The honors course, Elias P. Lyon, dean, University of Minnesota Medical School.

"Full Time," Frederick T. Van Buren, Jr., associate dean, Columbia University College of Physicians and Surgeons.

The handling of the superior student, David L. Edsall, dean, Harvard University Medical School.

Cooperative education in medicine, Newton Evans, president, College of Medical Evangelists, Calif.

The curriculum, Fred C. Zapffe, secretary, Association of American Medical Colleges.

Importance of physical plant in the correlation of teaching in medicine, Raleigh R. Huggins, dean, University of Pittsburgh School of Medicine.

Better correlation of teaching of science branches with clinical subjects, Henry C. Tinkham, dean, University of Vermont College of Medicine.

Administration of hospital medical school, Thomas Ordway, dean, Albany Medical College.

Promotion of friendliness between faculty and students, Walter L. Niles, dean, Cornell University Medical College.

An initiatory course for freshmen, Stephen Rushmore, dean, Tufts College Medical School.

The business session will be held at the Boston Medical Library, Saturday, March 7, at 9:30 P. M.

GRANTS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE IN AID OF RESEARCH

BY action of the Committee on Grants for Research of the American Association for the Advancement of Science the 1925 appropriation of $3,000 for grants has been allotted as follows:

Mathematics.

Henry W. Stager, Seattle, Wash. Building computing machine for supplying needs for construction of a list of prime numbers and a factor table. $250.

Physics.

E. K. Plyler, University of North Carolina. Spectrometer for researches in infra-red. $250.

Astronomy.

A. O. Leuschner, University of California. Towards a study of perturbations of minor planets. $300.

Geology.

G. R. Wieland, Yale University. Investigations for developing apparatus for cutting tough, elastic rocks. $150.

Zoology.

Paul S. Galtsoff, U. S. Bureau of Fisheries. Investigations of development of sponges from dissociated cells. $250.

S. O. Mast, Johns Hopkins University. Study of effects of chemicals on movement and response in amoeba. $250.

Botany.

E. B. Babcock, University of California. Investigations in European herbaria regarding Crepis. $300.

Josephine E. Tilden, University of Minnesota. Illustrative material to complete a monograph on brown algae of Pacific Ocean. $125.

R. B. Wylie, University of Iowa. Continuation of studies in wound reactions of certain plants of the Pacific coast. $150.

Anthropology.

American Journal of Physical Anthropology, endorsed by Section H. Aid toward publication. $250.

Psychology.

Asa A. Schaeffer, University of Kansas. Continuation of study of tendency of man to walk spirally when orienting senses not functioning. $100.

Anatomy.

L. T. Royster, University of Virginia Hospital. Continuation of studies on the sella turcica. $100.

Paleo-Pathology.

Roy L. Moodie, University of Illinois School of Medicine. Material showing evidences of diseases of pre-Columbian Peruvians and Pleistocene mammals preserved in California. $150.

Medical Biology.

Edward J. Wood, Wilmington, Del. Continuation of study of yeasts of mouth and intestine with reference to etiology of pernicious anemia. $250.

Robert S. Breed, New York State Experiment Station, Geneva. Continuation of study of red chromogenic rods. $125.

BURTON E. LIVINGSTON,
Permanent Secretary

SCIENTIFIC NOTES AND NEWS

THE University of San Marcos, which was founded at Lima, Peru, in 1551, has conferred the honorary degree of *Doctor en Ciencias* upon the following North American delegates to the Third Pan-American Scientific Congress, which met in Lima from December 20 to January 6: A. F. Blakeslee, of the Carnegie Institution; Edward V. Huntington, of Harvard University; Robert Cushman Murphy, of the American Museum of Natural History; Wilson Popenoe, of the U. S. Department of Agriculture; Marshall H. Saville, of the Museum of the American Indian (Heye Foundation), and Albert Sauveur, of Harvard University.

THE Buchan prize of the Royal Meteorological Society was awarded to W. H. Dines, F.R.S., at the annual general meeting of the society on January 21. This is the first time that the prize has been awarded.

RICHARD H. BURNE, curator of the department of comparative physiological anatomy in the Museum of the Royal College of Surgeons of England, has been awarded the honorary medal of the college for "services rendered to the advance of biological knowledge."

THE Royal Institute of Scientific Industrial Research of Sweden has awarded its gold medal of the first class to Johannes Ruths for his invention of a steam accumulator.

M. GEORGES CLAUDE has been elected by the French Academy of Sciences to the section of Applications of Science to Industry.

DR. OTTO HAHN, member of the Kaiser Wilhelm Institute of Chemistry and professor at the University of Berlin, has been appointed a member of the section of physical mathematics of the Berlin Academy of Sciences.

SENATOR MARCONI, of Italy, has been elected an honorary member of the Institution of Civil Engineers, England.

OSMUND CATTLIN, borough engineer, Lambeth, has been elected president of the Institution of Sanitary Engineers, England.

SIR OLIVER LODGE has accepted the presidency of the Radio Society of Great Britain in succession to Dr. W. H. Eccles, who has held the office for the past two years.

DR. ALEŠ HRDLIČKA was recently elected president of the American Anthropological Society, succeeding Dr. Walter Hough.

DR. B. D. SAKLATWALLA, general superintendent at the Bridgeville, Pa., plant of the Vanadium Corporation of America, has been elected vice-president of the company.

DR. K. F. KELLERMAN, associate chief of the Bureau of Plant Industry, who has served as a member of the Federal Horticultural Board for the past ten years, retired from the board last December because of the increasing pressure of administrative work.

DR. WILLIAM W. KEEN, emeritus professor of the principles of surgery and of clinical surgery, Jefferson Medical College, celebrated his eighty-eighth birthday on January 19.

PROFESSOR OTOKAR SRDINKO, professor of histology and embryology at the Czech Prague Medical School, celebrated his fiftieth birthday on January 1.

DR. ZEISS, of Hamburg, who has been in charge of the bacteriological work of the German Red Cross in Russia, now disbanded, has accepted a position in the Pasteur Institute at Moscow.

SAMUEL F. HILDEBRAND has been appointed superintendent and director of the biological station of the U. S. Bureau of Fisheries at Beaufort, N. C.

MYRON G. HOLMES, research assistant at the University of Maryland, has been appointed a junior physiologist for services in the Crop Chemistry Laboratory, Washington.

DR. A. B. STOUT, of the staff of the New York Botanical Garden, is spending six weeks during February and March in southern Florida in studies of the flower behavior of avocados with reference to pollination and the setting of fruit. This work is being done in cooperation with the Florida Avocado Association and with representatives of the state and of the Bureau of Plant Industry.

DR. O. A. JOHANNSEN, professor of entomology at Cornell University, sailed for Europe on January 27. He expects to visit universities, biological stations and entomological museums in various countries, returning to the university in September.

DR. WILLIAM BEEBE, of the New York Zoological Society; Dr. William K. Gregory, of Columbia University, and Dr. C. J. Fish, of the University of Pittsburgh, members of the deep-sea expedition of the New York Zoological Society, left New York on February 10 on a specially equipped ship, the *Arcturus*.

PROFESSOR HANS ZINSSER, of Harvard University Medical School, and a colonel in the Medical Reserve Corps, gave a lecture to the graduating class at the new home of the Army Medical School, Washington, D. C., on February 6, on "The phenomena of hypersusceptibility as they occur in infectious disease."

DR. F. K. RICHTMYER, professor of physics at Cornell University and national president of Sigma Xi, delivered the annual joint circuit lecture before the Missouri and Kansas chapters of Sigma Xi on January 27 and 29, respectively, on "What we see with the X-ray."

DR. C. W. STILES, of the United States Public Health Service, gave a series of three lectures on January 19, 26 and February 2 before the Research and Journal Club of the department of medical zoology, School of Hygiene and Public Health, Johns Hopkins University. His subject was the "International rules of zoological nomenclature."

DR. E. C. KENDALL, head of the chemical section of the Mayo Foundation for medical education and research at the University of Minnesota, gave a lecture at Columbia University on the Chandler foundation, February 13, entitled "The influence of the thyroid gland on oxidation in the animal organism."

DR. WILLIAM SNOW MILLER, emeritus professor of anatomy at the University of Wisconsin, gave a two weeks' course of lectures at the Post-Graduate School of Tuberculosis held under the auspices of the United States Veterans Bureau at the Veterans' Hospital at Castle Point, N. Y., during the month of January.

DR. WATSON S. RANKIN, state health officer of North Carolina, gave one of the Cutter lectures on preventive medicine at Harvard University on Feb-

ruary 12, on the subject of "Standards for public health department practices."

DR. RAY LYMAN WILBUR, president of Leland Stanford University, will be the orator of the day at the "University Day" exercises at the University of Pennsylvania on February 23.

DR. CHARLES H. VIOL, director of research in the laboratories of the Standard Chemical Company, gave an illustrated lecture on "Radium and radon" at a joint meeting of the American Electrochemical Society, the American Chemical Society, the Society of Chemical Industry and the Société de Chimie Industrielle, held on February 6.

DR. CHARLES B. BAZZONI, professor of experimental physics at the University of Pennsylvania, read a paper on "This year's atom" at a meeting of the American Philosophical Society, Philadelphia, on February 6.

SIR DAVID PRAIN gave the annual Sir George Birdwood Memorial Lecture, before the Royal Society of Arts, on January 9, the subject being "Government botanical gardens."

IN connection with the Liverpool Section of the Society of Chemical Industry, Sir Max Muspratt delivered a Hurter Memorial lecture at the University of Liverpool on January 16, on "Chemistry and civilization."

DR. J. H. JEANS delivered the sixteenth Kelvin lecture of the Institution of Electrical Engineers, England, on February 5. The title of the lecture was "Electrical forces and quanta." At the meeting a statuette of the late Sir Joseph Wilson Swan was presented to the institution by R. K. Morcom.

THE late Professor John Milne, the distinguished English seismologist, was among those commemorated recently in a ceremony at Tokyo in honor of living and dead foreign benefactors of Japan.

A PORTRAIT of the late Dr. W. H. Emerson, Ph.D. (Hopkins '86), professor of chemistry at the Georgia School of Technology, has been presented to Johns Hopkins University by the alumni of the university.

DR. DANIEL C. MANGAN, for the past 32 years professor of chemistry and physics at the Brooklyn College of Pharmacy, died on January 6, aged fifty-nine years.

DR. ENRIQUE FYNN, of Buenos Aires, noted for his work on proteolytic ferments, has died, aged fifty-three years.

AURELIO SANDOVAL, former secretary of public works and professor of engineering at the National University of Havana, Cuba, died on January 1.

DR. B. R. G. RUSSELL, of the Imperial Cancer Research Fund, who made important contributions to our knowledge of tumor transplantation and of the metabolism of cancerous tissue, died on December 22, aged forty-four years.

DR. J. McT. E. McTAGGART, fellow of Trinity College, Cambridge, since 1891, and the author of "The Nature of Existence," died on January 18, aged fifty-eight years.

DR. GASTON LALANNE, of Bordeaux, who contributed much to the science of prehistoric archeology through his discoveries at Cap-Blanc and Laussel in Dordogne, died on December 16 at the age of sixty-two years.

WILLIAM SACKSTON ATKINSON, artist in zoology and botany at Stanford University, died recently, aged sixty years. A correspondent writes: Entering Stanford University he received in 1899 the degree of A.B. with zoology as a major subject. Having unusual skill in drawing animals, he devoted himself especially to this phase of zoological study and for the last twenty years had been the chief artist in Stanford to work on fishes and flowers. Most of the recent papers on fishes of Eigenmann, Snyder and the writer have been illustrated by him, as well as the flowers in Abrams's North American Flora. Atkinson was a most serious, sincere and devoted worker, a man to whom those who knew him well were closely attached. His chief recreation was in the rearing and occasional hybridization of garden flowers, notably the Gladiolus.

THE American Society for Pharmacology and Experimental Therapeutics, at its recent session in Washington, D. C., reelected the following officers: *President,* John Auer, St. Louis University School of Medicine; *secretary,* E. D. Brown, University of Minnesota; *treasurer,* A. L. Tatum, University of Chicago.

THE Rush Society, of Philadelphia, for the correlation of medical lectures, has been reorganized with the following officers: *President,* Dr. Alfred Stengel; *vice-president,* Dr. Alfred N. Richards; *secretary,* Dr. E. B. Krumbhaar; *treasurer,* Dr. O. H. P. Pepper.

THE seventh annual meeting of the American Society of Mammalogists will be held in Washington, D. C., from April 8 to 10. Sessions devoted to the reading of papers, discussion and business will be held from 10 a. m. to 4:30 p. m., each day, in the New National Museum, 10th and B Streets, Northwest. An evening session will also be arranged, at which Mr. William P. Harris, Jr., of Detroit, will show the motion picture, "Vanishing game trails of Africa," taken by himself and Major A. Radcliffe Dugmore in East Africa. This picture ran for five months in London, England, but has been given only one public showing in America. Plans call for a

symposium on "The care of mammal material and records," which will be so conducted as to be of general interest. Opportunity will be offered to visit the National Zoological Park and other places of interest to members. One evening will be devoted to a dinner or banquet, and other social features may be arranged. Headquarters will be at the Hotel Harrington, 11th and E Streets, Northwest, three blocks north and one block west of the New National Museum.

THE third National Colloid Symposium will be held at the University of Minnesota on June 17, 18 and 19. The previous meetings have been very successful, having brought together two or three hundred chemists from all over the United States and Canada. This occasion bids fair to surpass the previous meetings. Dr. Herbert Freundlich, distinguished author of the classic "Kapillarchemie," will be the guest of honor. Only twenty papers will be presented, making possible an allotment of forty minutes as well as ample time for discussion. Titles for the program should be sent to Harry N. Holmes, chairman of the committee on the chemistry of colloids, Oberlin, Ohio.

THE date for the meeting in England of the American Institute of Chemical Engineers has finally been decided upon. Tentative reservations have been made on steamers reaching Liverpool, Sunday, July 12. The program consists of meetings with various British societies and excursions from July 13 to 23, with a three weeks' trip on the continent for those who can spend additional time in Europe. Those contemplating taking the trip are asked to communicate immediately with J. C. Olsen, secretary, 85 Livingston St., Brooklyn, N. Y.

THE next meeting of the International Research Council will be held at Brussels on July 7, 1925, and the days following.

AN exhibit was opened at the State Museum in Albany, N. Y., on February 12, showing the restoration of a forest of the Middle Devonian period, reconstructed from fossil remains of trees uncovered at Gilboa, where once an inland sea covered what is now the major portion of the Mohawk River Valley. The exhibit was dedicated as a memorial to Sir John William Dawson, former principal of McGill University, Montreal, who in 1869 and 1870 worked out the structure of fossil tree trunks uncovered by a spring freshet along the Schoharie River near Gilboa.

THE Edison Lighting Institute, containing exhibits depicting the history and development of the electric light, with laboratories for testing and demonstrating modern illumination devices, was dedicated at Harrison, N. J., on February 11. The institute includes a Bureau of Experts to assist in the development and improvement of home, commercial, industrial and street lighting. The exhibits cover every phase of lighting development since the invention of the first electric lamp by Thomas Edison in 1879.

DR. LEO HENDRIK BAEKELAND, honorary professor of engineering in Columbia University, has contributed $10,000 towards the endowment fund of the American Chemical Society.

A GIFT of £1,000 for research has been made to the alumni association of the University of Edinburgh by Dr. Charles Cooper, of San Francisco, a graduate of the university.

THE University of Manchester, England, has received from the General Electric Company a gift of an X-ray spectra apparatus for use in the department of physics.

PRINCESS MARIE, of Greece, has given the French Geographical Society more than 50,000 books on geography which belonged to her father, the late Prince Roland Buonaparte, who was for nearly fifteen years president of the society.

A GRANT of not less than £65,000 has been made by the Cotton Reconstruction Board, England, to the British Cotton Industry Research Association. The money is part of the funds raised by the Wartime Cotton Control Board, and not expended by that body in relief of the operatives by the time the mills resumed running after the war.

THE electric furnace equipment of the Bureau of Mines was completely destroyed by the recent fire which burned the old Mines building at the University of Washington. The bureau's equipment was housed in the building. It is expected that Congress will provide at this session for the replacement of the transformers, the switchboard and the other electric equipment which is essential to the work assigned to the Seattle Experiment Station.

UNIVERSITY AND EDUCATIONAL NOTES

THE University of Michigan has asked the state legislature for $3,192,100 for additional buildings and grounds, which includes $900,000 for a new museum and $465,000 for a modern observatory.

SIX laboratories and a research room in the Medical School of the University of Pennsylvania were swept by fire on January 24. The loss was estimated at $25,000.

PROFESSOR JOHN MALLET PURSER has made a gift of £10,000 to be administered for the benefit of the

School of Physic and the Schools fo Experimental and Natural Science of the University of Dublin, by a committee consisting of the heads of three of the scientific departments of the college.

THE will of the late D. A. Dunlap includes bequests of £50,000 to Victoria University, one of the colleges of the University of Toronto, and £20,000 to the University of Toronto for medical research.

DR. SUSUMU NUKATA plans to establish a medical college for women in the suburbs of Tokyo. The school will have a capacity of about 700 students and will be opened this spring.

DR. R. A. EMERSON, professor of plant breeding in the College of Agriculture, has been elected dean of the Graduate School of Cornell University, in the place of Dr. R. H. Keniston, who has resigned.

DR. SAM F. TRELEASE, formerly assistant professor of plant physiology in the University of Louisville, has been appointed associate professor of botany in Columbia University.

DR. H. C. TRIMBLE has resigned his position as assistant professor of chemistry at the University of North Dakota to become assistant professor of biochemistry at the Harvard Medical School.

DR. MARK R. EVERETT, a teaching fellow in the department of biological chemistry of the Harvard Medical School, has been appointed professor of physiological chemistry and pharmacology in the Medical College of the University of Oklahoma.

DR. E. M. SPIEKER has been granted leave of absence from the U. S. Geological Survey to give a course of lectures in geology at Ohio State University.

MAJOR R. V. SOUTHWELL is leaving the National Physical Laboratory of England in July to take up a lectureship in mathematics at Trinity College, Cambridge, where he will occupy the post formerly held by Professor G. I. Taylor until he became Yarrow professor to the Royal Society.

AT the University of Paris, M. Blaise has been appointed to the chair of organic chemistry to take the place of Professor Haller, who has retired; M. Tiffeneau to the chair of chemistry to take the place of Professor Joannis, retired, and M. Bougault to the chair of analytical chemistry to take the place of M. Villiers, also retired.

DISCUSSION AND CORRESPONDENCE

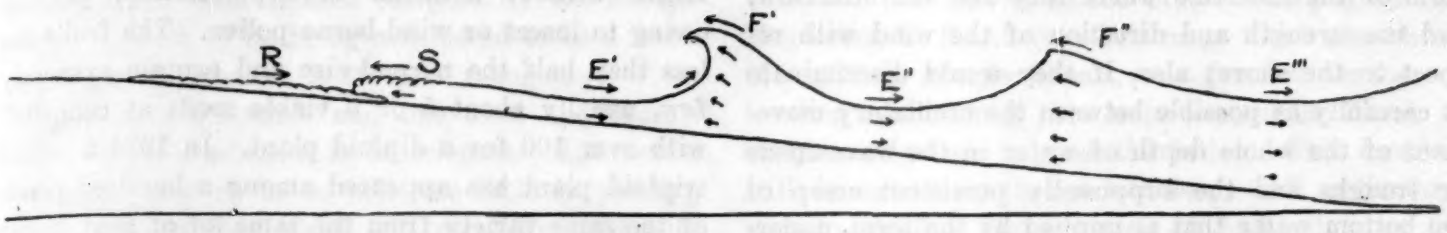
THE UNDERTOW MYTH

WHAT is the undertow? Repeated inquiry fails to discover any definite account of it, although among summer visitors to the seashore it is generally reputed to be a treacherous current that creeps or sweeps seaward along the bottom beneath the surf, and drags the unwary bather out beyond his depth where he is in danger of drowning. It is usually not thought to be of constant and universal occurrence, but to be stronger at certain times and places than at others; but when and where it does occur it is popularly believed to be a continuous seaward underflow, or bottom current of menacing strength.

The reputation that the undertow enjoys fails for two reasons to lead to a conviction of its reality. First, because the accounts of a supposed bottom current do not clearly distinguish it from the temporary seaward movement or wave-ebb, which normally takes place in an inter-crest trough, involving the whole depth of water from surface to bottom, but which in a few seconds is reversed into an equally temporary shoreward movement, or wave-flood, in the next inter-trough crest, where it again involves the whole depth of water: both of these temporary currents having greater velocity at the surface than at the bottom. Second, because the occurrence of an active and persistent seaward underflow at the bottom demands the occurrence of a correspondingly active and persistent shoreward flow at the surface; and except under doubly specialized conditions of wind direction and shore configuration, no such shoreward surface flow is to be expected.

The following sequence of events may ordinarily be noted: A surge of water, impelled by the plunge of a surf crest, rushes up the gentle slope of a beach, and is shortly followed by a reflux or seaward return of the same volume of water, R, Fig. 1: this down-slope reflux may be continued a short distance beneath the advancing front of the next surge, S; but it can not continue very far, because each surf-plunge by which the surge is impelled up the beach, is felt to the bottom, as may be known from the manner in which it stirs up a short-lived cloud of sand. An inexpert bather may be nearly swept off his feet by the reflux, as it swirls around his knees; and flustered mentally if not physically by the next inrushing surge, which foams waist-deep around his body. Then after a moment of still-standing water, he will be drawn outward again by the tide-like ebb[1]

[1] Waves and tides are so truly homologous that either of them may be described in terms of the other. Thus, a wave crest is high water, and the shoreward orbital water movement over the crest is flood tide; similarly, a wave trough is low water, and its seaward orbital movement is ebb tide; the front of a wave is rising tide, the back is falling tide; slack water, or the condition of no horizontal movement during the rise or fall of the tide has no corresponding term for waves, although the corresponding behavior in a wave is easily recognized. The



of the following wave-trough, E; and before he is balanced to resist it, he may be overwhelmed by the tide-like flood of the roaring surf, F′, head or shoulders high, and completely toppled over if he does not know how to escape the onrush by diving deep through it and coming up in the next trough. He is then, while trying to regain his footing, in no condition to notice that the seaward movement in that trough is only a second ebb, E″, 8 or 10 seconds after the first, but he may well be aware of the drag that it gives him toward the next wave crest, F″, where he may be once more immersed and more or less bewildered. Thus buffeted about, his most conscious moments will probably be during those 5 or 6 seconds when his head is out of water over a wave-trough; and as those moments are characterized by the seaward ebb of the shallowed water, while only the moments of confusion, 3 or 4 seconds in duration, are characterized by the shoreward flood of the higher and deeper water in the wave-crest, the ebb may make the stronger impression: and that this impression should be one of a rapid, undertowing current moving seaward, is not surprising when it is understood that the ebb current is felt around his body so strongly that he must brace himself to withstand it, while the most rapid shoreward over-flowing movement is high up in the wave-crest, where it is less easily recognized because the bather there, if he keeps his head out of water, can not touch the bottom with his feet.

On the other hand if a surf swimmer keeps his presence of mind, he may easily dive under the advancing waves and note by looking at the sandy bottom that the water is there moving slowly shoreward for a few seconds; or if he leaps up into the surf just before it breaks he will feel that the shoreward rush in the crest is a good match for the seaward sweep in the trough; and he may discover also that the fastest movement in the seaward ebb of the inter-crest troughs, as well as in the shoreward flood of the inter-trough crests, is at the water surface and not at the bottom. Is it not therefore probable that the idea of a persistent and dangerous seaward undertow comes more from the excited imagination of unpracticed bathers than from the deliberate observation of good surf swimmers?

Is it not also reasonable to insist that no continuous seaward under-towing current can be maintained unless it is supplied by an equally continuous shoreward surface flow? Under ordinary conditions there is practically no shoreward flow at the surface, in spite of the shoreward advance of the waves, as may be easily proved by watching any floating object: it rises and falls as wave crest and wave trough pass it; but in calm weather or under light winds, the float moves neither to nor from the shore; but it may move slowly parallel to the shore with the flood or ebb of the tide or with the drift of 'long-shore wind currents. During an off-shore wind, the surface water will be slowly brushed away, against the advance of the waves, and a float will then drift slowly seaward; and at such times a slow shoreward creep of the bottom water must be combined with the oscillatory movement of the water under the waves. During an on-shore wind, a corresponding seaward creep of the bottom water may be expected; but on a shore of simple outline such creep must be slow, too slow to overcome the rather active shoreward oscillation of the bottom water under a wave-crest.

It is only on a reentrant, bay-head beach—a pocket beach—between two salient headlands, and even there only while an on-shore wind is blowing, that a fairly active seaward undertow can be expected. At such a place and time, the surface water that is brushed into the whole breadth of the bay at its entrance may make a seaward escape chiefly by an undertow from near the middle of the beach; and such an undertow may acquire, under these doubly specialized conditions, a considerable velocity. But the reports that one hears of a dangerous undertow do not by any means all come from pocket beaches, or from days of on-shore winds.

It would be a favor to the incredulous author of this article if any of its readers who have had experience with "undertow" would send an account of it to the editor of SCIENCE; and the favor would be still greater if they would state whether they are good swimmers or not; and if they would describe the

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fact that a wave period is ordinarily only 6, 8 or 10 seconds and a crest-to-crest wave length in shore surf is only 100 or 200 feet, does not destroy the homology, although the period of the tide waves is 12h 26m, and tide-wave lengths near the shore may be many hundred miles. The chief unlikeness of the two phenomena is that the orbital water movement in surf waves is nearly circular, and seldom more than 5 or 10 feet in diameter, while the orbital movement in the tide is a very excentric ellipse, 6, 8 or 10 miles in length, and commonly only as many feet in height.

form of the shoreline where they felt the undertow, and the strength and direction of the wind with respect to the shore; also, if they would discriminate as carefully as possible between the oscillatory movement of the whole depth of water in the wave-crests or troughs and the supposedly persistent creep of the bottom water that is implied by the term, undertow; and finally, if they would state whether this discrimination was made on their own volition at the time the undertow was felt, or whether it is introduced as a memory record of the phenomena under consideration.

W. M. DAVIS

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TRIPLOIDY IN THE TOMATO

IN the late summer of 1923 a single unfruitful seedling plant was observed among ninety plants of the tomato variety Dwarf Aristocrat at Riverside, California. While all other plants of this variety were producing a heavy crop this plant, although flowering freely, had not set a single fruit and maintained a more erect habit of growth than the other plants which were borne down by weight of fruit. Cytological examination of this plant showed 36 chromosomes in the cells of the root tip. The somatic number of chromosomes in the tomato is typically 24, a number which was found in root tip cells of typical Dwarf Aristocrat and correspondingly 12 dyads in the pollen mother cells. The exceptional plant is therefore triploid. The plant has the general character of the variety but is conspicuous for its darker green color and for the "gigantic" character of certain organs. The leaves are larger and thicker, the petioles and stems stouter, giving the general effect of a plant exceptionally well nourished especially with nitrogen. The corolla and stamens are larger, the style on the average thicker but not as a rule longer, so that the stigma is more retruded than in a diploid plant. The form of the floral organs appears to be normal. Both under field and greenhouse conditions at Riverside the plant is nearly male sterile. The amount of pollen is much less than in a diploid and from 50 to 75 per cent. of the grains appear to be empty or their contents in process of disintegration. No germination of this pollen has been obtained in artificial medium and attempts to effect crosses with it have failed. On the other hand pollen of a diploid plant appeared to contain only about 5 per cent. of empty grains and over 50 per cent. germinated. Measurement of one hundred pollen grains of the triploid and of the diploid showed little difference in the *mean* size, but in the triploid the amount and range of variation is greater. When cross-pollinated the triploid readily sets fruit; it has also produced four fruits without artificial cross-pollination, perhaps owing to insect or wind-borne pollen. The fruits are less than half the normal size and contain extremely few, usually about 5 or 6 viable seeds as compared with over 100 for a diploid plant. In 1924 a second triploid plant has appeared among a hundred plants of the same variety from the same lot of seed, rather suggesting a common origin for the two triploid seedling plants. Progeny have been raised from the first found triploid, some of which contain extra chromosomes. A cytological and genetic study of these plants is now being made.

J. W. LESLEY

MARGARET C. MANN

UNIVERSITY OF CALIFORNIA

MOSELEYUM

A RECENT paper by Bosanquet and Keeley in the July number of the *Philosophical Magazine* shows that the search for the missing element of atomic number 43 is scientifically under way. Though their results were negative in this attempt, it is quite probable that we shall soon have definite evidence of its existence.

It would be an advantage to the cause of true science if we could avoid all possibility of a conflict of claims over names such as occurred in connection with the name "Hafnium" for element No. 72.

My suggestion is to call this missing element of atomic number 43 Moseleyum (symbol Ms), in honor of the young British physicist Moseley who did so much to establish the important facts concerning these missing elements, their location in the periodic scheme, with all that this means, and the limited number of the same. In fact no one who has studied modern physics can fail to appreciate the all-important significance for us of the original plate made up by Moseley from the little separate X-ray photograph which he pasted together in step-like fashion one above the other, showing the wonderful scheme of atomic steps. In every land to-day copies of this plate are to be found, and it is not too much to say that such will be the case for many years to come.

There are still five missing elements, those of atomic numbers 43, 61, 75, 85 and 87. The one indicated by Moseley himself on the original plate of atomic number 21 was discovered and named Scandium. It would have been very suitably termed Moseleyum, in honor of the one who presented the first undeniable evidence of its existence. Let us remedy this situation while it can still be done. Of the five, 85 and 87 are among the radioactive substances, 75 lies between Tungsten 74 and Osmium 76, while 61 is one of the rare earths. It would seem that either 43 or 75 would be located soonest of the five. Number 43

has sometimes been termed temporarily eka-manganese on account of its being considered to be a metal with properties similar to those of manganese.

Surely the best name and one most appropriate under the circumstances is Moseleyum. The actual discoverer, whoever he is, will lose little in yielding to such a suggestion which will certainly meet with general approval. Moreover, it is a name better and more international in character like true science itself than a latinized name of the discoverer's own kingdom or republic.

Whether we say that cruel war or that destiny decreed that young Moseley should be denied the great and happy privilege of pushing on to greater completion his wonderful and far-reaching experimental results, we know that his research has helped us in our search after truth. His step-like photographs have simplified our steps and we now roam on ahead.

There is little that we can do that will more fittingly show our appreciation of the best of his life's labor. Wherever the Periodic Table will be shown after this, let the outstanding name in the center of it be "Moseleyum," as an inspiration to the teacher and the earnest student and as a monument to man's own intelligence and the value of research.

To all I say: "Element 43 no longer but 'Moseleyum.' Make it unanimous."

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MUSCLE SHOALS VS. MUSSEL SHOALS

DR. A. E. ORTMANN'S suggestion on pp. 565 and 566 of the December 19th issue of SCIENCE to change the official spelling of Muscle Shoals to read Mussel Shoals, because of the fact that the Shoals are named after the well-known bivalves that abound in that locality, brings to mind a similar agitation in the south a few years ago when the Shoals were beginning to attract the attention of the investing public. A leading newspaper then advocated making the change for the same reasons advanced by Dr. Ortmann. The writer, who at that time was engaged on a waterpower investigation of the Tennessee River for the War Department, and happened to be familiar with the early history of the geographic name, was able to set at rest the minds and as a result the old spelling has since prevailed. The story is briefly this:

The writings of early settlers and explorers in that part of the United States give the spelling uniformly as Muscle Shoals, often followed by a note that the name was derived from the *muscle shells* for which the place had always been famous with the Indian tribes. The earliest map of the Shoals made by the government was that of 1832, prepared by officers of what was then known as the Corps of Topographical Engineers, U. S. Army. This map, which also shows the spelling Muscle Shoals, was for the purpose of locating a canal with nine locks around the Shoals to enable navigators to pass the latter. This canal is still in existence, though obsolete. All indications were to the effect that the name of the bivalve in those days was *muscle shell.* This was substantiated by referring to dictionaries and encyclopedias, both old and new editions. One standard dictionary, edition of 1875, showed a wood cut of the shell and gave "muscle shell" as the only form of spelling. Later editions give both forms of spelling. About 1895 the form "mussel" is given the preference. The most recent editions of Funk & Wagnalls' Standard Dictionary and Webster's International still mention under "muscle" the name of the shell as an old form.

In the earlier writings mention is made of the fact that the "muscle shell' is so named because of the powerful muscles that close the two valves. Any one who has worn out his jack knife pearl hunting on the Tennessee and tributaries can testify as to these muscles and wonders why "mussel shell" is not spelled "muscle shell."

The writer urges adherence to the old form of spelling the name of the Shoals for two reasons: It has been established through long usage, extending over more than a century; the new form of spelling *mussel* is no improvement over the old form *muscle.*

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SCIENTIFIC BOOKS

The Life, Letters and Labours of Francis Galton. By KARL PEARSON. Vol. I. Birth 1822 to Marriage 1853. Cambridge (University Press), 1914. Pp. xxiii + 246. 56 plates and 5 pedigree charts. Vol. II. Researches of Middle Life. Cambridge (University Press) 1924. Pp. xi + 425. 54 plates.

HAVING as its subject one who will probably be written down in the history of science bracketed with Darwin as one of the most important figures in nineteenth century biology, and for its author the pioneer explorer of a new field of biological thought and methodology, Pearson's "Life of Galton" is bound to be a work in the very first rank of significance. And it is. Such a biography as this stands alone. Biographies as monumental in point of size as this will be when finished are not rare. In contradistinction to all such, however, the thing which makes this unique is that it is a thorough piece of *scientific* research on the life of a great *scientist.* It is less entertaining than Galton's autobiographical "Memories," but immeasurably more valuable. For

it is a veritable document which will stand for all time as a source in the history of science.

The history of the book itself is of interest and must be told if the significance of the whole is to be understood. Pearson's original intention was to complete the work in two volumes and to supplement them by a collected edition of Galton's writings. The latter part of the project became impracticable, chiefly because of the increased costs of publication which have developed since 1914, and apparently in part for other reasons not clearly stated. In any case a revision of the whole plan became necessary.

> Thinking the matter out carefully, I determined that this second volume of Galton's biography should to a large extent supply the reader with what the collected works would have done; that the *résumé* of memoirs, books and articles should be full enough to enable the anthropologist, the geneticist and the statistician to appreciate what Galton had done, and so starting from his suggestions make a more thorough map of a district, where Galton would only claim to have made a chart of the cardinal points. In taking this determination I was soon aware that it meant adding a third volume to this *Life*. I have had to postpone to that volume the discussion of Correlation, the Statistical Theory of Heredity, Personal Identification and Description and Eugenics, together with many letters, characteristic of Galton's mentality and of his affectionate disposition. But that volume seems an easy one after the present, for it largely deals with work done after Galton had been recognized as a master and friend.

There seems to be now some possibility that a fourth volume will be necessary before the work is done. The ten years' delay between the two volumes which have appeared was unfortunate but unavoidable. This was not the only scientific enterprise which was abruptly halted by the general outburst of acute insanity in the summer of 1914. It is to be hoped, from many points of view, that the Life will from now on be rapidly pushed to its conclusion.

With so much by way of background let us consider the content and method of the two volumes before us. The first deals with Galton's ancestry, his childhood and boyhood, his *Lehrjahre* and *Wanderjahre*, the fallow years from 1844 to 1849, and, in part, with his explorations in Africa. Of these subjects the ancestry is the one most extensively treated. About one quarter of the first volume is devoted to a masterly piece of genealogical research on Galton's forebears, with a wealth of portrait and other illustrations. The four grandparents of Francis Galton were Samuel Galton, Lucy Barclay, Erasmus Darwin and Elizabeth Collier. Pearson shows clearly and in detail that there was abundantly represented in these four ancestral lines high types of intellectual, artistic, physical and moral qualities. It can not be maintained that from Erasmus Darwin alone Galton derived his scientific ability.

When we examine the four grandparents of Francis Galton, it is difficult to give precedence to any one of them as more noteworthy than another. Lucy Barclay has been described by one of her granddaughters as a very clever, beautiful women, very dignified and queen-like in her manner. She possessed great talent and refinement, and she studied history and literature of every kind to educate her children. She brought the physique of the Barclays and Camerons and something of the courtly bearing of the Stuarts and the ability of their greater ancestors into the Galton stock. Samuel Galton himself contributed determination, industry and a strong element of Quaker stubbornness—but at the same time wide public and social sympathies and a distinct scientific bent. Elizabeth Collier, of more slender figure than Lucy Barclay, was not behind her in beauty. She supplied an artistic instinct, a joyousness in life, an appreciation of form and expression which are less usual among the Society of Friends; in her ancestry we trace in addition both love of adventure and love of learning. And last, but not least, we have Erasmus Darwin, who presented his descendants with that great gift, the scientific imagination—the match which light a strong fire in the solid fuel of other characters be provided.

The chapter on childhood and boyhood give a valuable picture of the educational methods of the time, and of the reaction of a gifted and original boy who was interested in science and bored by the classics. Of the years of medical education at Birmingham and London, and of mathematical education at Cambridge, between the ages of 16 and 21, one's first and strongest impression is that Galton had an extraordinarily good time while he was getting his formal education. With plenty of money, unusual social gifts and connections, a rare sense of humor and an unfailing joy of living he missed very few of the pleasant features of college life, whether of the intellect, of society or of sport. That he somewhat crowded the business of living in the later of these years is evidenced by a breakdown in health which compelled the giving up of the attempt for mathematical honors. But that no permanent harm was done is equally evidenced by his activities in after life and his great longevity.

The five years from 1844 to 1849, described by Pearson as "fallow years," were again mainly devoted to having a good time. Galton's father died in 1844. He was left with ample means and virtually complete freedom to do what he liked. He was tired of formal study. He was fond of hunting, of shooting, of travel and of society. These tastes he indulged. Why not? Pearson somewhat unhumorously endeavors to account for this period of apparent discontinuity in Galton's intellectual life by an analysis of his hereditary make-up. Galton's own

explanation, which was that he had "many wild oats to sow," seems human, satisfactory and sufficient.

The "fallow period" culminated and came to an end in Galton's exploring trip to Africa. His book "Tropical South Africa" is one of the most interesting accounts of travel in unexplored territory ever written. It went through a number of editions. Probably few biologists of the present generation have ever read it.

The second volume of the Life opens with these words:

> We left Francis Galton at the end of our first volume aged 32, married, with many social friends, and ample competence, and a mind trained both in observation and analysis. His experience had been such that he knew more of mathematics and physics than nine biologists out of ten, more of biology than nineteen mathematicians out of twenty, and more of pathology and physiology than forty-nine out of fifty of the biologists and mathematicians of his day. Added to these advantages he had gained a knowledge of man and his habits in various lands; this gave him additional width of view, if it rendered less obvious to him that field of investigation wherein his powers were ultimately to achieve their most noteworthy successes.

This second volume is written, as already explained, on a different plan from the first. It contains, to begin with, much more matter. Not only are there more pages, but the type is noticeably less heavily leaded, with the consequence of a great many more words to the page. The six chapters deal with the following subjects: VIII. Transition Studies: Art of Travel, Geography, Climate. IX. Early Anthropological Researches. X. The Early Study of Heredity: Correspondence with Alphonse De Candolle and Charles Darwin. XI. Psychological Investigations. XII. Photographic Researches and Portaiture. XIII. Statistical Investigations, especially with regard to Anthropometry.

This volume is a masterpiece. I can not too strongly urge upon every statistician, anthropologist, psychologist and biologist (especially the student of any phase of human biology) the importance of reading it. He will find in it a perfect wealth of suggestive ideas for his own researches, as well as a most stimulating picture of the extraordinary originality and fecundity of Galton's mind. Like all really original persons Galton had a vast lot of ideas which he never had time to work out. Fortunately for the world he put many of them on paper in one form or another, and with masterly skill and insight Pearson has dug them out of memoranda as well as from published papers and books, and put them together in orderly fashion. Furthermore he has done a great deal of work on many of them in the way of bringing them into relation to present-day modes of thought and of notation, and has shown how they bear upon current problems.

Galton first attained eminence in the fields of geography and meteorology. The "Art of Travel" was, and still is, an extremely valuable handbook for the traveller, indeed even for the casual and occasional camper. It went through many editions. It has been well-nigh forgotten now that Galton was the first person in Europe (and perhaps in the world) to devise and publish a weather map. He also invented a number of instruments for plotting and analyzing meteorological data mechanically. He played an important rôle in the organization and development of the official British weather service.

The transition from physical geography to anthropology was a simple one. It began with an interest in the human side of geography. One of the earliest papers marking the transition is a discussion of the first steps in the domestication of animals by savage peoples, in which Galton suggests that animals were kept as pets long before there was any thought of their utility, and that the limitation to the forms that can be domesticated is set by traits of the animals themselves, with the result that about all the animals capable of domestication have been domesticated at some time or other. The real foundation stone of Galton's anthropological work was a paper published in 1864 on "Hereditary Talent and Character." Pearson says that he had been working on the subject for six or seven years before. The main thesis was the equal inheritance of psychical and physical characters. The method is that of his 1869 book, "Hereditary Genius," which first brought general recognition of his leadership in this field. In this paper he clearly enunciated the two doctrines with which his fame has been popularly most associated, namely, eugenics and the law of ancestral inheritance.

> As we can not doubt that the transmission of talent is as much through the side of the mother as through that of the father, how vastly would the offspring be improved, supposing distinguished women to be commonly married to distinguished men, generation after generation, their qualities being in harmony and not in contrast, according to rules, of which we are now ignorant, but which a study of the subject would be sure to evolve. (p. 163.)

> The share a man retains in the constitution of his remote descendants is inconceivably small. The father transmits, on an average, one half of his nature, the grandfather one fourth, the great-grandfather one eighth; the share decreasing step by step in a geometrical ratio, with great rapidity. (p. 326.)

Pearson points out that this is not an exact statement of the law as it came later to be formulated, but when it is remembered that it was published in the very early stage of his work on heredity it is a remarkably close prevision.

It is impossible to review in the space available the wealth of detail which makes up this second volume. Much of great interest must be passed over. The correspondence with De Candolle and Darwin on heredity includes the difficulty between Galton and Darwin about the experimental work on pangenesis, which Pearson handles with fine diplomacy and tact but still in such a way as to permit the reader to form a sound judgment for himself as to what actually occurred. The psychological investigations can only be mentioned. The chapter on "Photographic researches and portraiture" must be more particularly noticed, because in composite photography was one of Galton's most ingenious ideas. It was technically so difficult that it was never followed up thoroughly. But its theoretical bearings and potentialities are so great that it seems certain that some day some one will build the proper superstructure on the solid foundation Galton laid. Pearson sketches these bearings in the following passage:

To grasp fully Galton's photographic activities at this time we must bear in mind two important facts. He was still searching for some physical features which should have high association with the mental characters. This attitude was perfectly reasonable at that date, because not only no correlations between such characters had been determined, but the methods of measuring correlations were of the crudest kind. Further Galton was a traveller, and every traveller is accustomed as he passes along to notice that the racial mentality changes with the change of the physical characters. The conception therefore naturally arises that physique and mentality are highly correlated. The American Indian, the Negro, or the Arab has each his individual physique, and each also his individual mentality. But this appearance of high correlation may be most deceptive; it does not follow that there is any organic linkage between the physical and psychical characters. If a race be started from a pair of individuals both possessing a physique of type A and a mentality of type A′, we may find in later generations an apparent linkage of A and A′ in all the members; but this is not a true correlation, and a cross-breeding may show that A and A′ have no organic relation, and can be at once separated. In the second place Galton did, like most men of his generation and probably like most of us to-day, consciously or unconsciously, give weight to physiognomy. So impressed by physiognomy is mankind in ordinary every-day life, that we hardly realize how much confidence we place in it. We say a person is good or bad, is intelligent or stupid, is slack or energetic, on what is too often only a rapid physiognomic judgment. The custom is so universal as a rough guide to conduct, that we are almost compelled to believe that there is in human beings an intuitive or instinctive appreciation of mental character from facial expression. Galton differed only from the mass of us in desiring to ascertain on what physiognomic appreciation is based. He belonged to a generation in which the influence of Lavater and the belief in some form of phrenology were still appreciable. He accordingly sought to isolate types and to measure deviation from facial type, in order to determine whether facial variations were correlated with mental variations. He was really attempting to make a true science out of the study of physiognomy.

The final chapter deals with Galton's early statistical investigations, which were mainly along anthropometric lines, but also included many studies in the theory of statistics. From a technical point of view this is one of the most valuable chapters in the book, because of Pearson's penetrating comments on Galton's work. The following quotation from the lecture on "Generic Images" published in the Proceedings of the Royal Institution in 1879 epitomizes the point of view from which Galton approached the problems in which he was interested—and the range of his interests knew no bounds—perhaps better than anything he ever wrote.

General impressions are never to be trusted. Unfortunately when they are of long standing they become fixed rules of life, and assume a prescriptive right not to be questioned. Consequently, those who are not accustomed to original inquiry entertain a hatred and a horror of statistics. They can not endure the idea of submitting their sacred impressions to cold-blooded verification. But it is the triumph of scientific men to rise superior to such superstitions, to devise tests by which the value of beliefs may be ascertained, and to feel sufficiently masters of themselves to discard contemptuously whatever may be found untrue. (p. 168.)

It is unfortunate that the manner in which this biography has had to be prepared precludes the possibility of an index until the whole work is finished. This lack is especially felt in the second volume. But even the mildest of critics of any point whatever must be disarmed in the face of the extraordinary excellence of this biography. It is a wholly worthy memorial of a very great man.

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SPECIAL ARTICLES

CHROMOSOMES AND SEX IN SCIARA

A STUDY of the chromosomes of *Sciara similans* Joh. (manuscript)[1] has disclosed a condition which, so far as known to the writer, has not been observed in any other organisms. Both sexes of this fly are diploid. The chromosome group of the female consists of four symmetrical pairs of chromosomes,

[1] The writer is greatly indebted to Professor O. A. Johannsen for identifying this as a new species and for giving it a manuscript name, which is used here. His taxonomic description will appear shortly.

two of which are rod-like and two V-shaped, as shown in Fig. 1. That of the male consists of four pairs like those of the female, and in addition two larger and individually distinct chromosomes, one V-shaped and the other J-shaped (Fig. 2).

Thus the male possesses two more chromosomes than the female. These two chromosomes are confined to the male line, passing from father to son in each generation. In the latter respect they resemble an ordinary Y-chromosome, but they differ from the Y-chromosome in other features. The Y-chromosome is a member of a pair and segregates at maturation. It has a mate, X, which is derived from the female parent and which passes into the female offspring. The two large chromosomes in *Sciara,* on the other hand, are unlike all the other chromosomes and have no mate or mates among them; they do not pair with or segregate from any of the others. It is not known, as yet, whether there is a true XY pair in this species or not.

Peculiarities are also observed in the maturation divisions in the male. The two large chromosomes apparently do not undergo synapsis—at least they are separate elements in the primary spermatocyte figures (Fig. 3). Consequently the first spermatocyte group consists of six chromosomes—the four pairs being represented by bivalents. Both of the large (univalent) chromosomes divide longitudinally at this division and their daughter halves go to opposite poles (Fig. 4). But one of the small V-shaped bivalents goes precociously to one pole undivided (Fig. 5). The chromosomes at this pole remain in the spermatocyte, while those at the opposite pole are cast off in a small bud, suggesting the polar body of an egg (Fig. 6).

Since the second spermatocytes are not appreciably smaller than the first (and for other reasons) it has not been possible to distinguish positively between first and second maturation divisions—or, indeed, to be certain that a second division occurs. Several indications of such a distinction have been observed, however, and it is believed that both divisions do occur. If so, the second is essentially like the first, with all the chromosomes dividing except the precocious V-shaped bivalent (not one of the two large chromosomes). Again the pole receiving the precocious chromosome remains in the spermatocyte and the other is cast off in a bud. The significance of the behavior of the precocious chromosome is unknown, partly because oogenesis has not yet been studied to ascertain what the oocyte contributes to the fertilized egg.

Whether both divisions occur in the male, or only one, the end result should be essentially the same, *i.e.,* each spermatozoan should receive both of the large chromosomes, both members of the precocious V-shaped pair and one member from each of the other three pairs. If these observations are correct (and the figures are clear and easily analyzed in most cases) all the spermatozoa should be male determining and all the fertilized eggs should give males. Females, therefore, should arise by parthenogenesis, unless a chromosome elimination occurs at some later stage.

But simple parthenogenesis apparently does not occur, for all virgin females tested (thirty in one experiment and many more subsequently) have failed to give offspring. Possibly the female-producing eggs need only the stimulus of the sperm to start development, as in *Rhabditis.*[2] This seems improbable, but it can be tested genetically, and experiments are under way for that purpose.

Sex ratios from single wild females or laboratory pairs in this species range from all females to all males, with various intermediate proportions. Of 27 wild females tested, 12 gave only females, 10 gave only males and 5 gave mixed broods. Similar results are given by laboratory pairs. It seems probable that this behavior is associated with the cytological features described above, although further genetic study, with egg counts, etc., is prerequisite to an explanation.

No detailed discussion of the above problems will be attempted at this time, but a word may be said as to the nature of the evidence presented. The cytological observations are based on an examination of over a hundred specimens. Spermatogonial or spermatocyte figures have been studied in specimens from twenty-four different parentages, including seven wild sources. Ovarian figures have been obtained in material from thirty different parentages, including eleven wild sources. In four cases brothers and sisters were examined. Spermatocyte divisions

[2] Kruger, *Zool. Anz.,* 40, 1912.

have been obtained in males from both bisexual and all-male broods (from single mothers) and ovarian figures have been obtained in females from bisexual and all-female broods. This makes it seem certain that the difference between the chromosomes of the two sexes represents a normal condition, not peculiar to any one stock or race and not due to hybridization of different species. It also tends to indicate that the maturation phenomena are the same in all males, regardless of their source, although this point can hardly be established until further genetic study has been completed.

Stock cultures of this species have been kept in the laboratory for a year (over 18 generations) and others have been kept for three or four generations. Many intercrosses have been made. Both unisexual and bisexual broods have been obtained from these, but no sterile combinations have been found—which tends to indicate that we are dealing with only one species. If not, and the aberrant sex-ratios are due to hybridization of true species, these species must be very similar and the crossing must occur freely in nature.

Similar chromosomal relations of the sexes and a similar type of spermatogenesis have been observed in a closely related species, *S. pauciseta* Felt, and in a more distantly related species of the same genus. It seems possible, therefore, that the chromosomal relations described above are characteristic of a number of species—perhaps of the genus.

ADDENDUM: Since the above was sent to press evidence has been obtained which indicates that probably all the spermatocyte divisions described here are from secondary spermatocytes and that the first division is very different—involving no division of the two largest chromosomes. The account of spermatogenesis should be corrected accordingly, although the main feature (the passage of both large chromosomes into all the spermatids) is not altered.

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THE EFFECT OF LIGHT ON THE PERMEABILITY OF LECITHIN

BECKING and Gregersen have recently contributed an interesting paper[1] under the title given above. They use an adaptation of the method devised by the writer,[2] in which the electrolytic resistance of the more dilute of two solutions separated by a more or less permeable diaphragm is measured from time to time and the permeability of the diaphragm deduced from the change in resistance. By this method Becking and Gregersen claim to have shown that the permeability of membranes consisting of lecithin and collodion in equal proportions was increased by illumination. Their paper unfortunately leaves the matter somewhat in doubt, for two reasons which are here considered.

The first doubt of the validity arises by reason of the fact that as far as one can judge from the data given, equilibrium is attained when the distilled water in one compartment has been entered by only enough salt from the other compartment to reduce its resistance from 15,000 to 30,000 ohms to about 2,000 ohms. The upper compartment originally contained 0.2N KCl, and the lower one distilled water; since they appear to have been of nearly equal volume, they should both have contained approximately 0.1N KCl at the end of the experiment. But the observed change in resistance was nowhere nearly adequate to account for an increase in KCl concentration from practically none (distilled water) to 0.1N, and the final conductance was so small that one almost unavoidably concludes that diffusion through the membrane stopped while there was still a difference in concentration between the solutions separated by the membrane, and while there was still a concentration gradient through it. In this case there must have been factors, other than light, which controlled the permeability, if in fact the membrane was permeable to KCl at all. This can not be assumed unless, as in the writer's experiments on *Laminaria*[2] it can be shown that: (1) no change in resistance occurs when both compartments are filled with the more dilute solution, so that no diffusion gradient through the membrane exists: (2) the increase in resistance in the more concentrated solution keeps pace with the decrease in resistance in the more dilute solution.

In this connection it should be noted that under the conditions of the experiment the rate of change of conductance in the lower cell should theoretically be nearly

$$\frac{dx}{dt} = K(a - 2x),$$

where x = total change in conductance of the more dilute solution at the time t, and a = original difference in conductance of the two solutions. Integrating, we obtain

$$Kt = \log \frac{a}{a - 2x}$$

from which we may, if a is known, calculate values of K from the observed data. No data being given as to the value of a, it may still be of interest to assume a probable value, namely $a = 50 \times 10^{-4}$ ohms^{-1}, and to calculate the values of K from the data given by Becking and Gregersen.

[1] Becking, L. B., and Gregersen, M. I. *Proc. Soc. Exp. Biol. Med.* (1924), XXII, 130.

[2] Brooks, S. C., *Bot. Gaz.* (1917), LXIV, 306.

The value of x at the beginning of the experiment may be taken as being so small as to be negligible. The high value, 0.31×10^{-4} ohms^{-1}, or more, which Becking and Gregersen give for their initial reading, is probably due to convective effects incident to setting up the experiment and may be neglected. The same influences probably account for the high value of x at the end of the first hour. In making these calculations the values of x were divided by the values of $\frac{\Lambda}{\Lambda_0}$ appropriate to the presumable concentrations; this correction was neglected by Becking and Gregersen.

The results of such calculations are given in Table I, and show that the theoretically correct formula gives results as accurate as could be expected, since no precautions were taken to minimize convective effects. It is accordingly unnecessary to have recourse to Becking and Gregersen's empirical formula with its many arbitrary constants.

TABLE I

Values of K in the equation $K = \frac{1}{t} \log \frac{a}{a - 2x}$ when $a_0 = 50 \times 10^{-4}$ and $x_0 = 0$.

t observed	$x \times 10^4$	$\log \frac{a}{a-2x}$	K
hours	ohms^{-1}		
1	6.49	1.0267	.0114
2	9.48	1.0394	.0084
3	13.38	1.0567	.0080
4	17.93	1.0773	.0081
5	23.43	1.1035	.0086
6	28.88	1.1306	.0089
7	36.08	1.1687	.0097

The second and more serious fault in Becking and Gregersen's argument lies in the fact that according to their data the conductance of the solution in the lower compartment into which KCl is supposed to be diffusing, increases when the apparatus is illuminated, but decreases when the illumination is over. If all changes in conductance are to be interpreted as due to passage of KCl through the lecithin membrane, then KCl must be supposed to diffuse out of the lower cell against the concentration gradient after each period of illumination. It is hardly to be supposed that water diffused into the more dilute solution, although this does occur under certain conditions (negative osmosis). Either of these explanations seems relatively improbable and one is driven to inquire whether the changes in conductance occurring during and after illumination can not be attributed to some cause other than changes in KCl concentration. Although it is stated that "temperature fluctuations during illumination kept within $\pm 1°$ C.," this still allows us to assume that an increase of 2° C. might have occurred during illumination, which would increase the conductivity by 4.6 per cent.[3] This is nearly two thirds of the largest increase in conductance which was observed, and suggests the need for further information as to whether the temperature of the solution *between the electrodes* was measured, as can be done by means of a thermocouple, or whether, for example, the measurements refer to air temperatures taken by a mercury thermometer, the bulb of which was inside the asbestos box enclosing the apparatus. Only in the former case could we be sure that the whole effect was not due to change in the temperature of the solution in the conductivity compartment.

These criticisms do not preclude an increase in the permeability of lecithin-collodion membranes upon illumination; but the hypothesis that such a change occurs is evidently in need of further experimental support.

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[3] Kraus, C. A. "The Properties of Electrically Conducting Systems." New York, 1922, p. 147.

THE MINERALOGICAL SOCIETY OF AMERICA

THE fifth annual meeting of the Mineralogical Society of America was held at Cornell University, Ithaca, New York, on Wednesday, December 31, 1924. Officers for 1925 were elected as follows: *President,* Arthur S. Eakle, University of California, Berkeley, California; *vice-president,* H. P. Whitlock, American Museum of Natural History, New York City; *secretary,* Frank R. Van Horn, Case School of Applied Science, Cleveland, Ohio; *treasurer,* Alexander H. Phillips, Princeton University, Princeton, New Jersey; *editor,* Walter F. Hunt, University of Michigan, Ann Arbor, Michigan; *councilor,* 1924–28, William F. Foshag, U. S. National Museum, Washington, D. C.

The following papers were presented:

The modern study of minerals: Presidential Address: HENRY S. WASHINGTON (jointly before Mineralogical Society and Geological Society).

Bentonite as a one-dimensional colloid: EDGAR T. WHERRY.

A tabulation of the aluminum silicate minerals: EDGAR T. WHERRY.

Bentonite and Montmorillonite: CLARENCE S. ROSS AND EARL V. SHANNON.

A new theory of the composition of the zeolites: A. N. WINCHELL.

Studies in the mica group: A. N. WINCHELL.

The temperature-pressure conditions during the formation of smoky quartz and amethyst: EDWARD F. HOLDEN.

Electrical conductivity of ore minerals: PAUL F. KERR AND CHARLES K. CABEEN.

A computing and direct reading Jolly balance: EDWARD H. KRAUS.

A calcified log from the Pittsburgh coal near Morgantown, West Virginia: CHARLES R. FETTKE.

Camsellite from California: ARTHUR S. EAKLE.

Foshagite, a new calcium silicate from Crestmore, California: ARTHUR S. EAKLE.

Note on the crystallization of thaumasite: ARTHUR S. EAKLE.

Preliminary report on the crystal structure of some metallic sulphides: LEWIS S. RAMSDELL.

The characteristics of primary calcite in igneous rocks: T. L. WALKER AND A. L. PARSONS.

Evanescent pink sodalite, or hackmannite, from near Bancroft, Ontario: T. L. WALKER AND A. L. PARSONS.

X-ray diffraction measurements upon the diopside-like pyroxenes and their bearing upon the nature of augite: R. W. G. WYCKOFF, H. E. MERWIN AND H. S. WASHINGTON.

The space group of diopside: R. W. G. WYCKOFF AND H. E. MERWIN.

The crystallography of sucrose: A. F. ROGERS.

An interesting and useful property of zones: A. F. ROGERS.

A new type of sand calcite crystals from Monterey County, California: A. F. ROGERS AND R. D. REED.

A fulgurite from South Amboy, New Jersey: W. M. MYERS AND ALBERT B. PECK.

THE WESTERN MEETING OF THE AMERICAN MATHEMATICAL SOCIETY

THE twenty-second western meeting of the American Mathematical Society was held at the University of Chicago on December 26, 1924. Fifty-two members of the society were present.

It was announced that at the April meeting of the society in Chicago Professor W. D. MacMillan would give a symposium lecture on "Some of the mathematical aspects of cosmology."

At the scientific sessions, presided over by Professor T. H. Hildebrandt, vice-president of the society, the following papers were presented:

Sense relations between the pairs of corresponding triangles of a Desargues configuration: F. E. WOOD.

Bundles and pencils of nets on a surface: E. P. LANE.

A theory of a general net on a surface: V. G. GROVE.

On the polynomial of the best approximation to a given continuous function: J. A. SHOHAT.

The figuratrix in the calculus of variations: P. R. RIDER.

Theorems concerning transversals of the (n+)—hedron in n—dimensional space: H. F. MACNEISH.

A new theory of the rational equivalence of linear transformations or pairs of bilinear form: L. E. DICKSON.

Rational theory of pairs of bilinear forms in the singular case: L. E. DICKSON.

On the solution of diophantine equations by means of ideals: G. E. WAHLIN.

Subgroup composed of the substitutions which omit a letter of a transitive group: G. A. MILLER.

The transform in the abstract definitions of groups: W. E. EDINGTON.

Asymptotic distribution of characteristic numbers in the problem of the elastic bar: H. T. DAVIS.

Surface transformations applied to special dynamical problems: H. BETZ.

The frequency law of a function of several variables with given frequency laws: E. L. DODD.

Note on isogonal trajectories of geodesics: L. INGOLD.

The parameter group of a continuous group in function space leaving a manifold invariant: I. A. BARNETT.

Existence theorems for differential equations: H. J. ETTLINGER.

Polynomials and their residue systems: A. J. KEMPNER.

Depreciation and other economic problems involving maxima of functionals: H. HOTELLING.

On certain linear algebras: J. B. SHAW.

The papers by Professors MacNeish, Wahlin, Betz, Dodd and Ettlinger were read by title.

ARNOLD DRESDEN,
Assistant Secretary

MEETING OF THE UTAH ACADEMY OF SCIENCES

A MEETING of the academy was held at the Agricultural College, Logan, on October 31 and November 1, 1924. A brief business session was held at which a number of new members were admitted to membership in the academy. The program consisted of the following papers:

Acid tolerance of strawberry plants: LAVAL S. MORRIS.

Piracy on the Provo and Weber rivers: WILLIAM PETERSON.

Capillary potential in relation to irrigation and drainage: O. W. ISRAELSON.

Wheat straw studies: THOMAS L. MARTIN.

Some anomalous results in the measurements of capillary potential function by the vapor pressure method: L. B. LINFORD and WILLARD GARDNER.

The precision of the porous cup method of measuring the capillary potential: WILLARD GARDNER and C. A. CHAMBERS.

A new concept of light carrying medium: LLOYD GARRISON.

Advantages to be derived from locally developed sugar beet seed: DEAN A. PACK.

Contribution to the geology of the southern Wasatch: MURRAY O. HAYES.

Sound intensity measurements: ORIN TUGMAN.

Occurrence of nematode and crown wart in alfalfa fields in Utah: B. L. RICHARDS.